Construction Methods

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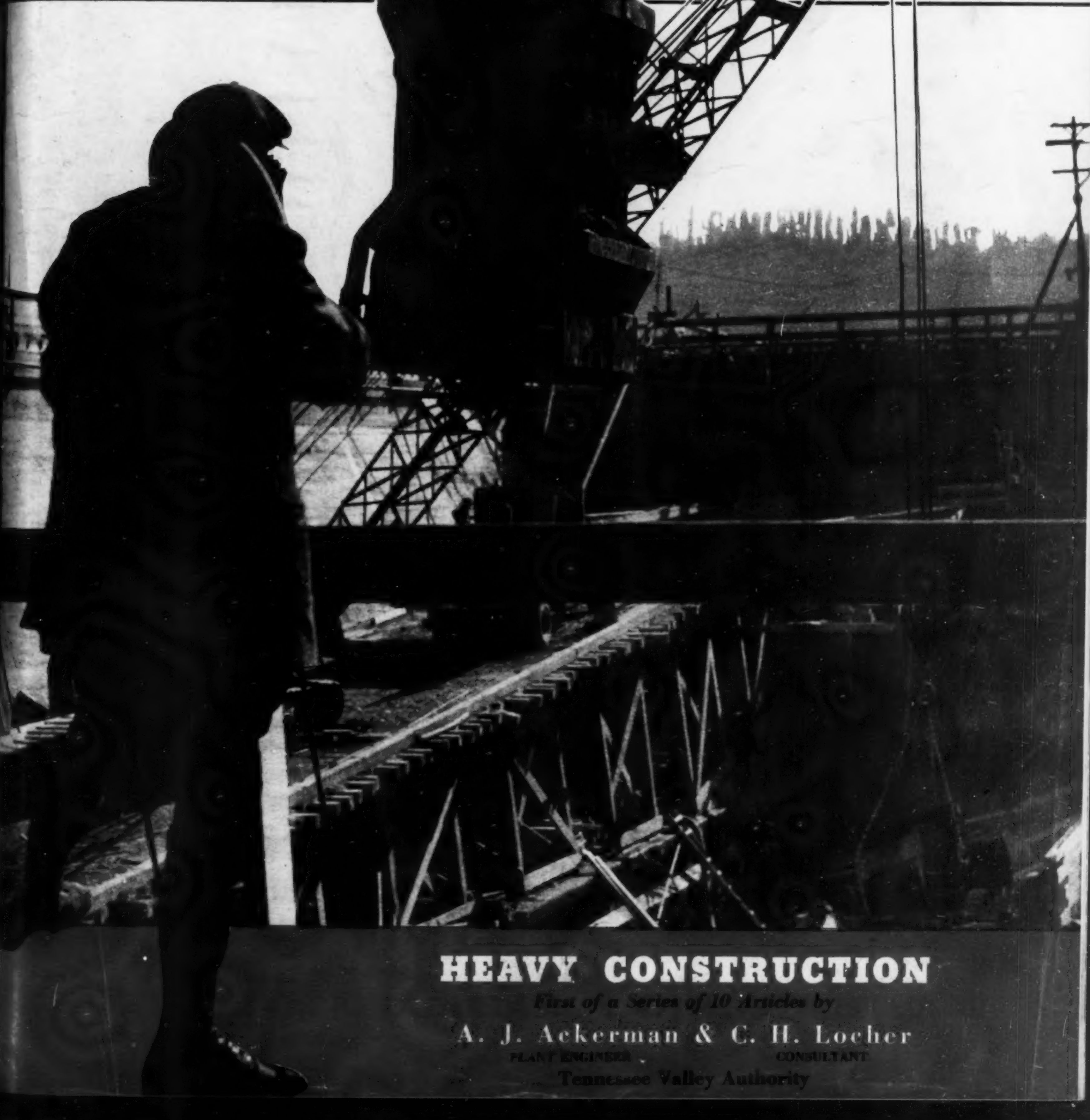

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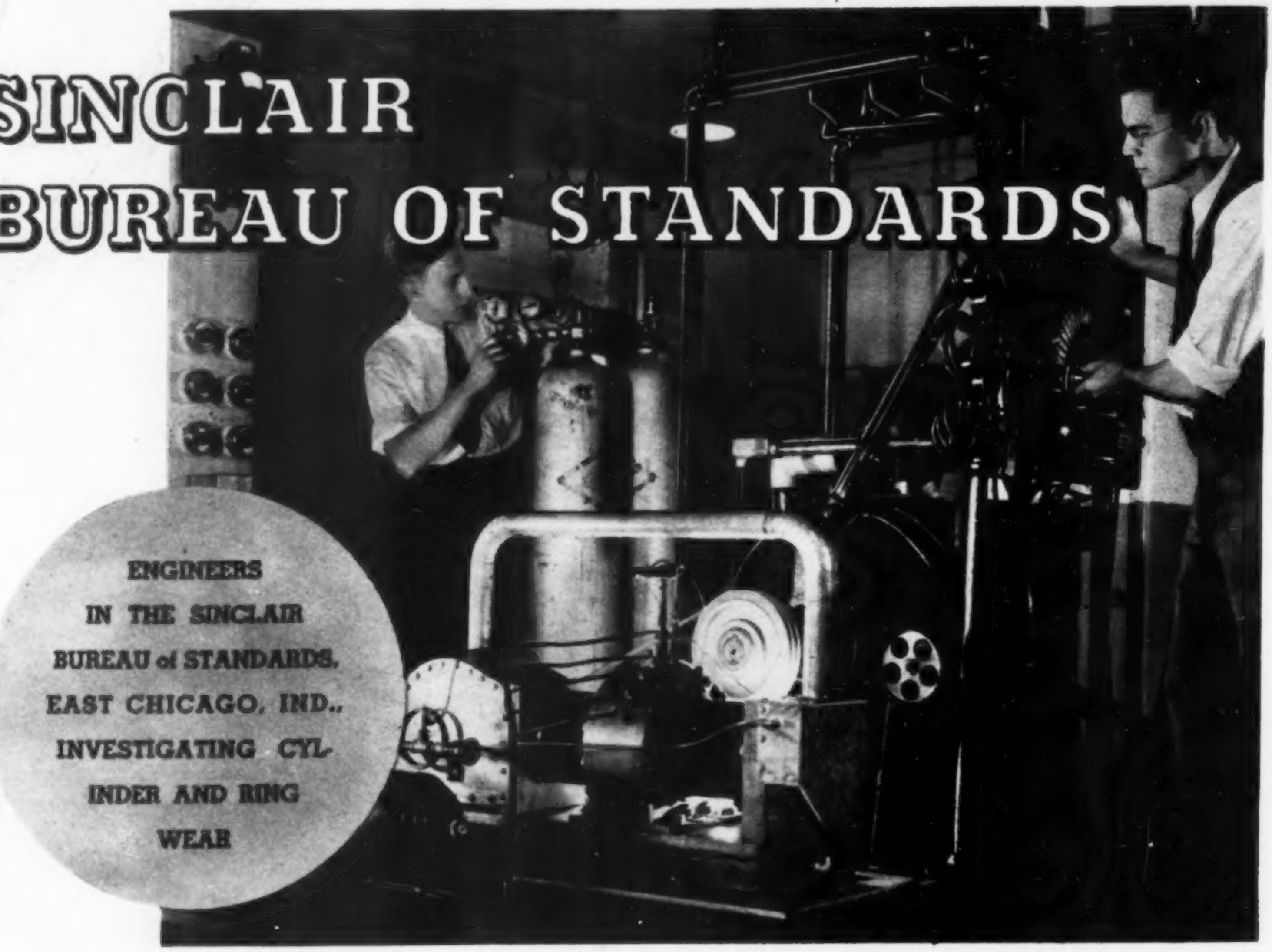

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Construction Methods

McGraw-Hill Publishing Company, Inc.,
330 West 42nd St., New York

Robert K. Tomlin, Editor

NOVEMBER, 1935

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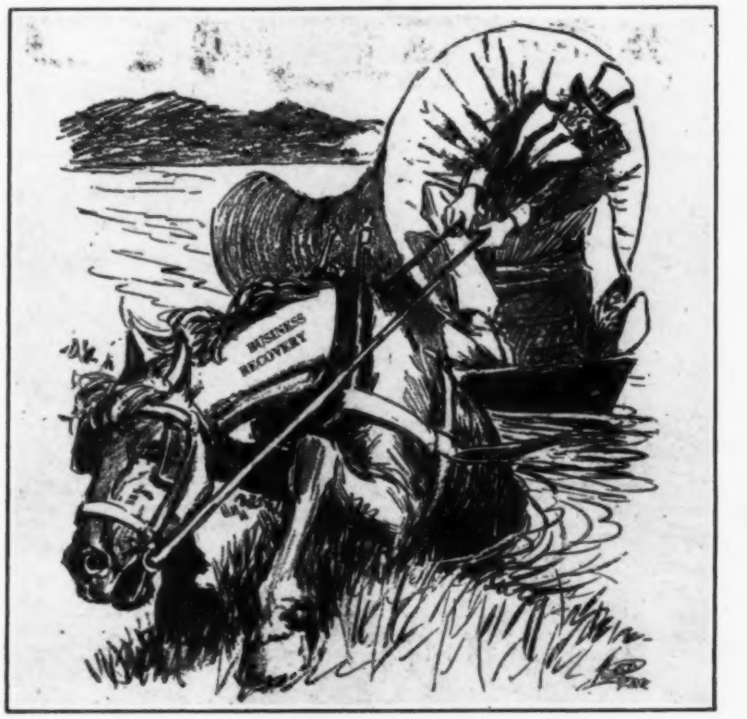

Pease, in the Newark (N. J.) Evening News

Give Him His Head

Planning and Plant for Heavy Construction

● In this issue *Construction Methods* presents the first of a series of articles which, it is believed, will prove of outstanding value and interest to construction men. Under the head "Planning and Plant for Heavy Construction," Adolph J. Ackerman, construction plant engineer, and Charles H. Locher, construction consultant, both of the Tennessee Valley Authority, will discuss in approximately ten chapters the principles and practices of job layout and the selection and use of equipment for large dams and appurtenant works. As the authors point out in the opening installment of the series this month, modern equipment has expanded the scope of heavy construction to a point where it is now feasible to undertake projects which were only dreams a decade or two ago. In tackling such projects, however, the constructor who proceeds by hit-or -miss methods, without a carefully developed plan of operations, has a slim chance of coming out with a profit.

Today there is insufficient recognition of the principle that on heavy construction the key to success is the proper planting of the job. This means intelligent study of the construction problem *in advance* of preparing a bid or actually starting work and the selection of the right kind and amount of mechanical equipment to assure the maintenance of the best rate of production to meet a predetermined progress schedule. Under present conditions there is far too much guesswork done in making up estimates for prospective work—witness variations of 50 or even 100 per cent between the high and low bids on many large projects and the notoriously high mortality in the business life of firms or individuals engaged in construction.

Many contractors still fail to realize the full significance of the changed conditions that govern modern construction. The problem, today, is not so much a management of men as it is a management and coordination of machine operations. This point Mr. Ackerman and Mr. Locher stress repeatedly in their discourse Their advice is not academic; it is based on long and varied practical experience in the field and should prove helpful in guiding construction men away from the pitfalls into which so many of them have fallen in the past. Throughout the series of articles runs this basic theme: "Construction profits today are dependent upon adequate advance expenditures for plant and facilities that will produce the lowest final cost of the job."

The authors are qualified to speak with authority on the subject of heavy construction. The veteran, Mr. Locher, with a background of more than half a century of active participation in large-scale construction, dating back beyond the days of the Chicago Drainage Canal in the 90's and covering work of varied types—dams, tunnels, waterways, railroads, bridges, subways—needs no introduction to the construction industry. His most recent engagement is as construction consultant on the three big dams—Norris, Wheeler and Pickwick Landing—which the TVA is building. Mr. Ackerman, of a younger construction generation, has had a wealth of practical experience on dams and other forms of heavy construction. He became construction plant engineer for the TVA after he had served in a similar capacity on the recently completed Madden dam in the Canal Zone at Panama. His service record includes, also, the Conowingo, Calderwood, Chute-a-Caron and other large dam and power projects.

Mr. Ackerman and Mr. Locher talk a language that construction men can understand. What they have to say, we believe, will be well worth listening to.

Discriminatory Effects of the 30-Hr. Week

● Under the original PWA regulations the construction industry had a full-sized dose of the 30-hr. week, particularly on highway construction. While intended to spread employment, it proved to be a cumbersome and costly restriction, necessitating work either on a 3-day week basis or the splitting of shifts into 5-hr. periods for a 6-day week. Construction employees, with lean pay envelopes for only 30 hr. of work, and contractor employers, with normal operating procedure completely disorganized by the forced curtailment of working hours, have found by actual experience that the 30-hr. week is ill-adapted to working conditions in the construction industry. It is pertinent, therefore, to present the following facts and conclusions from a recent report on the 30-hr. week by the National Industrial Conference Board:

Increased business failures and unemployment would follow as a result of discriminatory effects of the 30-hr. week on different industries and different enterprises in the same industry. Under the 30-hr. week there would be a marked increase in labor costs. The ability of an industry to shift the additional labor cost would depend largely upon: (1) the increase in the cost of labor in relation to total cost; (2) the degree to which the demand depends upon price for the product at any stage of production and at the point where it reaches the ultimate consumer. The 30-hr. week, therefore, would be most burdensome on those industries where the percentage of labor costs in total cost is large.

The ability of an industry to shift the increased labor cost to the consumer would be determined by the nature of the demand for its products. The demand for certain commodities is highly inelastic; that is, the consumers have to buy them even though the price is increased. Food, clothing, and fuel are such commodities. These industries find it relatively easy to shift the increases in the cost of production to the consumers.

Other industries produce goods or services for which the demand is highly elastic in the sense that purchases may be postponed or avoided if the rise in prices is greater than the consumers are able or willing to pay. Building construction, machinery and luxury articles fall in this classification. The difference in the elasticity in demand for these two types of goods is indicated by the much greater decline in employment during adverse times in durable goods industries than in those producing non-durable goods. In the construction industry, the National Industrial Conference Board shows, employment declined more than 60 per cent from 1929 to 1932, as compared with a decline of only 20 per cent in the food products and tobacco industries. A 30-hr. week, according to the board, would consequently affect most unfavorably the durable goods industries in which labor costs are a relatively large proportion of total costs and which are subject to an elastic demand. They would find it most difficult to shift the added cost to the consumers. Since they are now operating at an extremely low level and without profits, the result would be business failures and increased unemployment.

The millions of workers who are now employed and who would not receive an increase in weekly wages as a result of the 30-hr. week would suffer a decrease in real wages, leading to a material reduction of the standard of living of workers. On the other hand, persons now unemployed and who would obtain employment under the 30-hr. week, would benefit at the expense of those workers who are now engaged in gainful occupations and who represent an enormous majority of the available working force. The 30-hr. week, therefore, is a work-sharing program.

The decrease in the real wage would result in demands for higher money wages. Since industry would not be able to meet such demands at present without increasing prices, the result would be strikes, lockouts and other labor disputes which would further increase production costs, decrease production and reduce the general standard of living.

A Job Well Planted *Means* a Profit Half Earned

SINCE THE WORLD WAR construction has felt more and more the effects of a change in production methods that came with the turn of the century. That change, commonly called "mechanization", consists of the more effective application of power through machinery to increase the productive capacity of labor. In this change is found the key to man's conquest of scarcity, first step on the road to greater abundance for all.

For some time construction did not feel this change so much as did the mill and factory industries. The reasons for that lag are evident. Each construction job must be done at its site; it cannot be lumped with others into a mass operation that makes feasible the establishment of huge fixed production facilities. Moreover, the prevailing practice of awarding each new job on a competitive basis to an independent constructor fosters the survival of a large number of producing units. Other factors also do their part, but these are the basic influences that delayed the application of twentieth-century production methods to construction practice.

BUT FOLLOWING the World War new conditions prevailed. Increasing refinement of technical design and the use of new materials put a premium on construction skill and drew many technically-trained men into construction. Larger projects made desirable and possible the realization of lower unit costs. Curb on immigration and warbred high wages for unskilled labor, so much used on construction, made necessary a higher productivity for that labor. These and other considerations, notably the design of better and better equipment, soon made construction men more keenly appreciative of modern production methods. Although it is unlikely that construction ever will realize the refined efficiencies of factory production,it has travelled far since the days when a contractor's chief asset was driving power that could get the most out of the backs of men and animals. Viewed against that background, construction practice shows progress quite in keeping with that achieved by Henry Ford since he built his first cars.

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IT HAS BEEN said that a job well planted means a profit half earned. In keeping with this basic principle, this series has been planned to help construction men to approach the task of estimating and executing every type of heavy work with the slant of a production engineer, conscious that his plans and plant, once determined, will set definite limits to his earnings. Skillful and energetic management remains, as always, a prime essential, but all the drive and resourcefulness of management cannot make up for inappropriate or inadequate layout or equipment. Once committed to a defective plan, the construction man is almost as helpless as the production manager of an automobile factory once he has set his new production line in motion. At that stage the die has been cast; in modern practice the efficiency of all the workers is governed by the frame within which they must work.

Whatever construction men may get out of these particular articles it is to be hoped that, through them, Messrs. Ackerman and Locher will stimulate a keen interest in planning and planting for more efficient construction. For that is the foundation on which we must rebuild the prosperity of the industry and of everyone dependent on it for his wages, salary, commissions, profits or dividends.

Willard Chevalier

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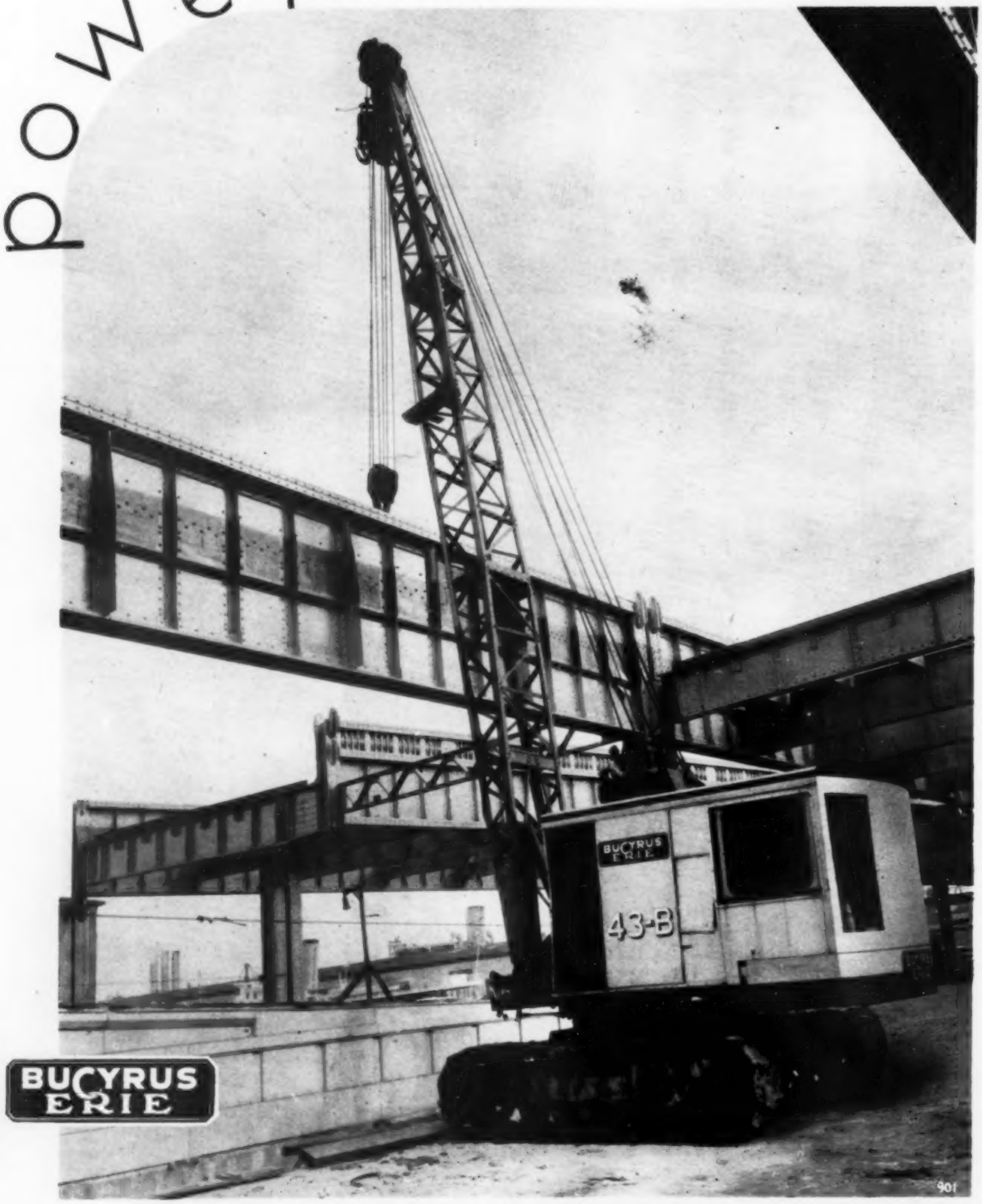

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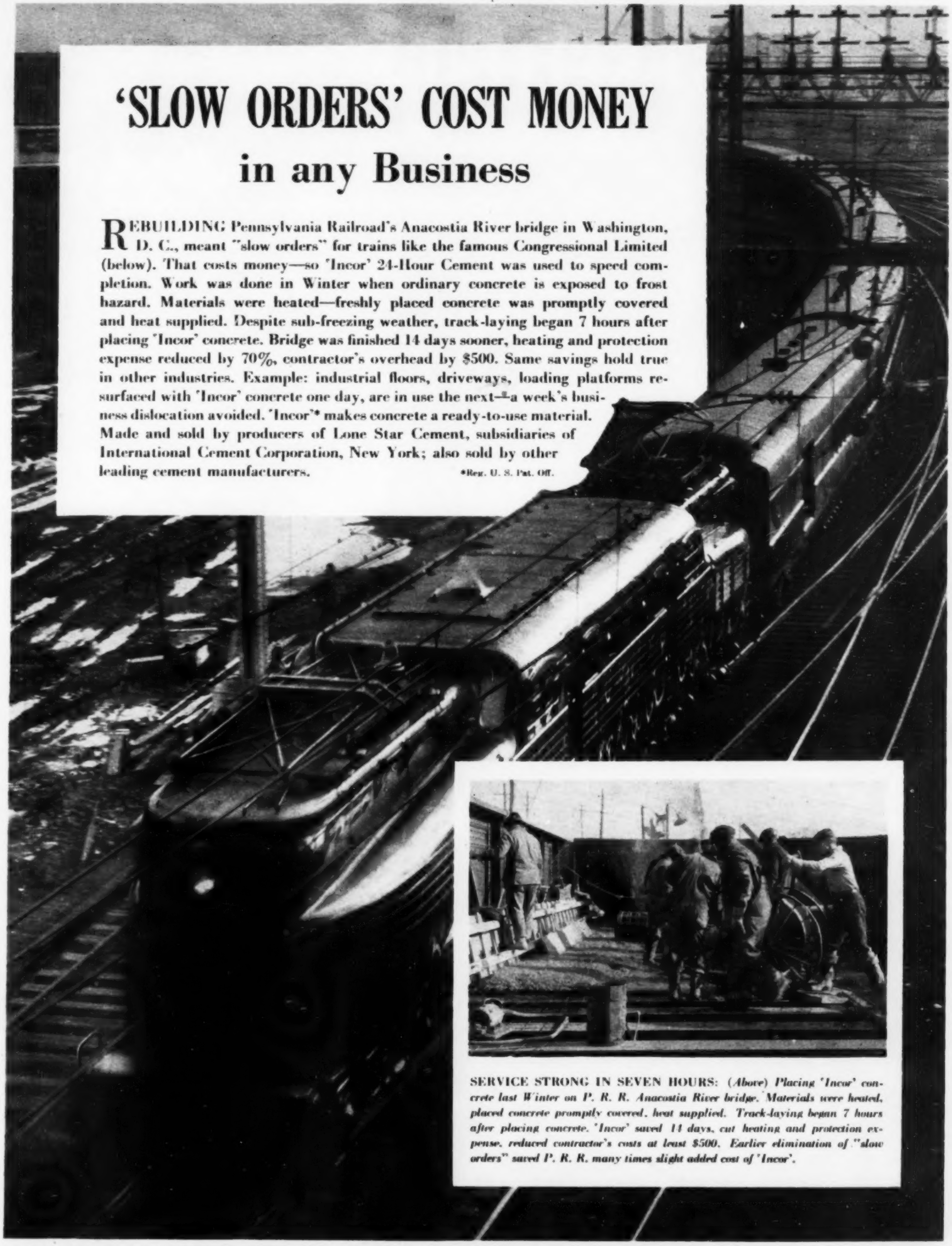

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in any Business

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*Reg. U. S. Pat. Off.

SERVICE STRONG IN SEVEN HOURS: *(Above) Placing 'Incor' concrete last Winter on P. R. R. Anacostia River bridge. Materials were heated, placed concrete promptly covered, heat supplied. Track-laying began 7 hours after placing concrete. 'Incor' saved 14 days, cut heating and protection expense, reduced contractor's costs at least $500. Earlier elimination of "slow orders" saved P. R. R. many times slight added cost of 'Incor'.*

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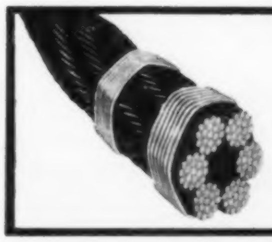

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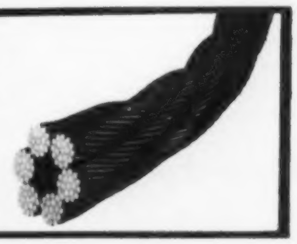

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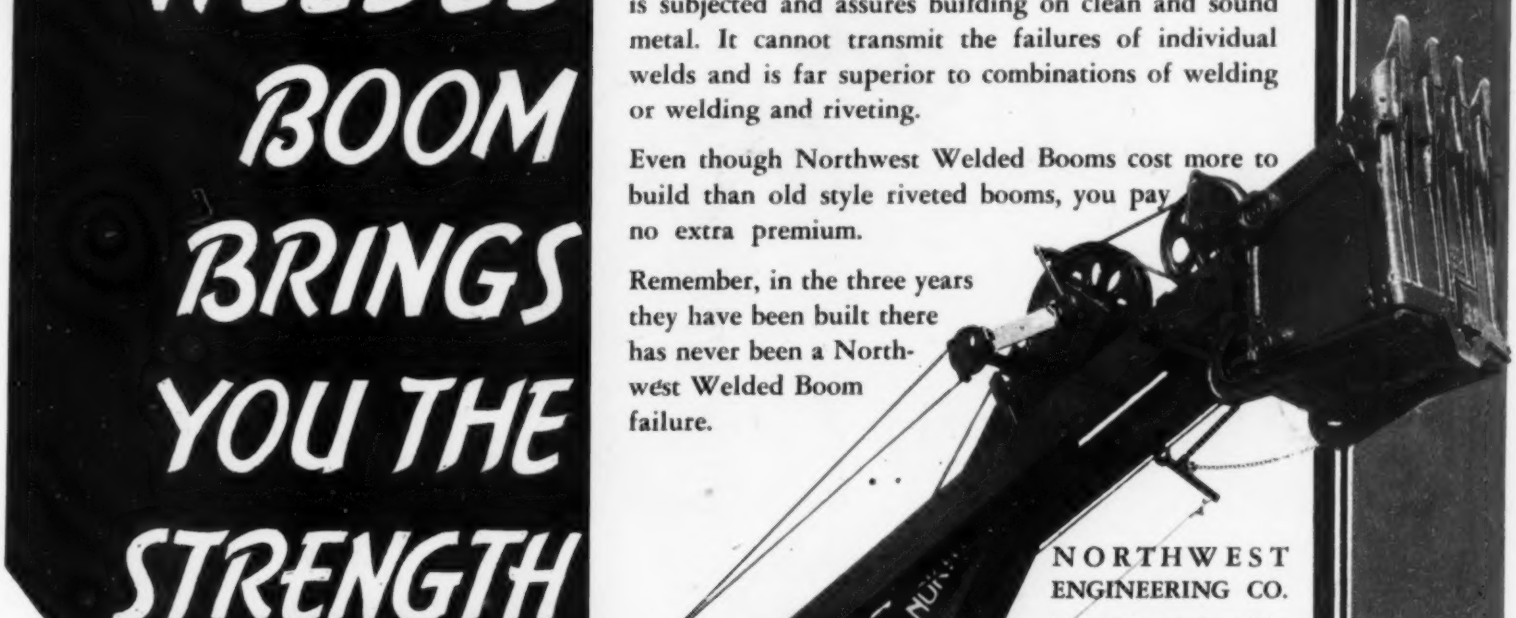

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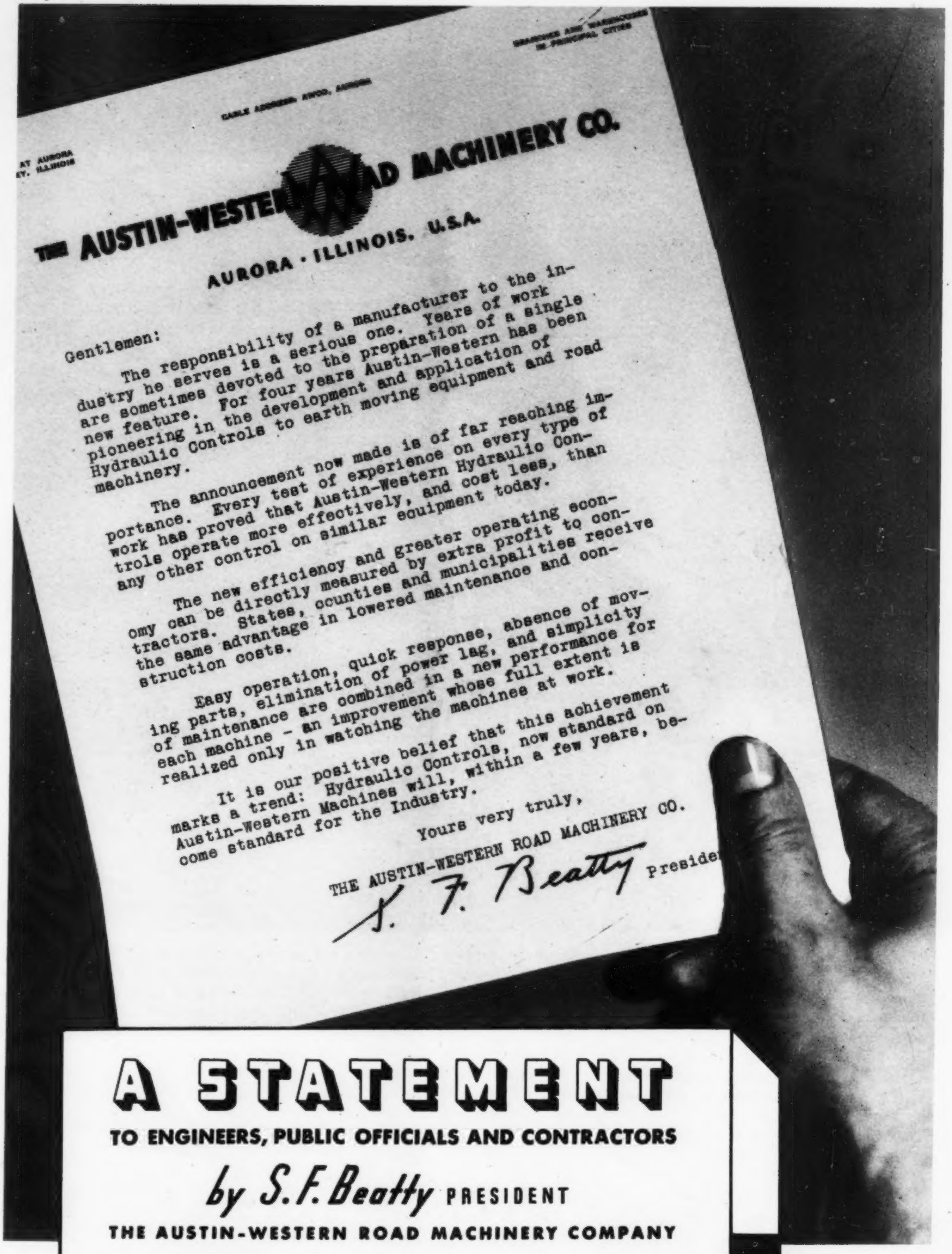
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by S. F. Beatty PRESIDENT
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A Job Well Planted *Means* a Profit Half Earned

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Construction Methods

ROBERT K. TOMLIN, Editor

Established 1919—McGraw-Hill Publishing Company, Inc.

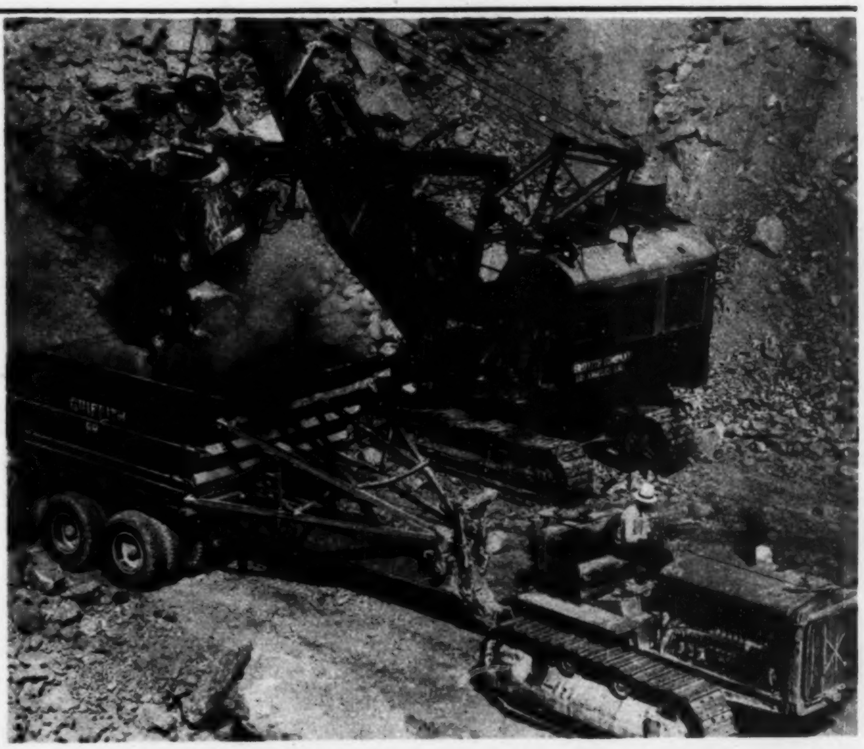
Volume 17—Number 11—New York, November, 1935

All-American Canal

Excavated by

Three Different Methods

EXTENDING 80 mi. from the Colorado River, north of Yuma, Ariz., to and across California's Imperial Valley, the All-American Canal, included at an estimated cost of $38,500,000, as an essential part of the Boulder Canyon project, is one of the world's largest irrigation ditches. In its upper reaches the canal has a bottom width of 160 ft., a water depth of 21 ft and a water surface width of 232 ft. Cuts 100 ft. deep are required in sand hill areas. Big draglines, power shovels and horse-drawn fresnos (the latter to provide relief employment for residents of Imperial Valley) are among the earth-moving methods employed under direction of the U. S. Bureau of Reclamation.



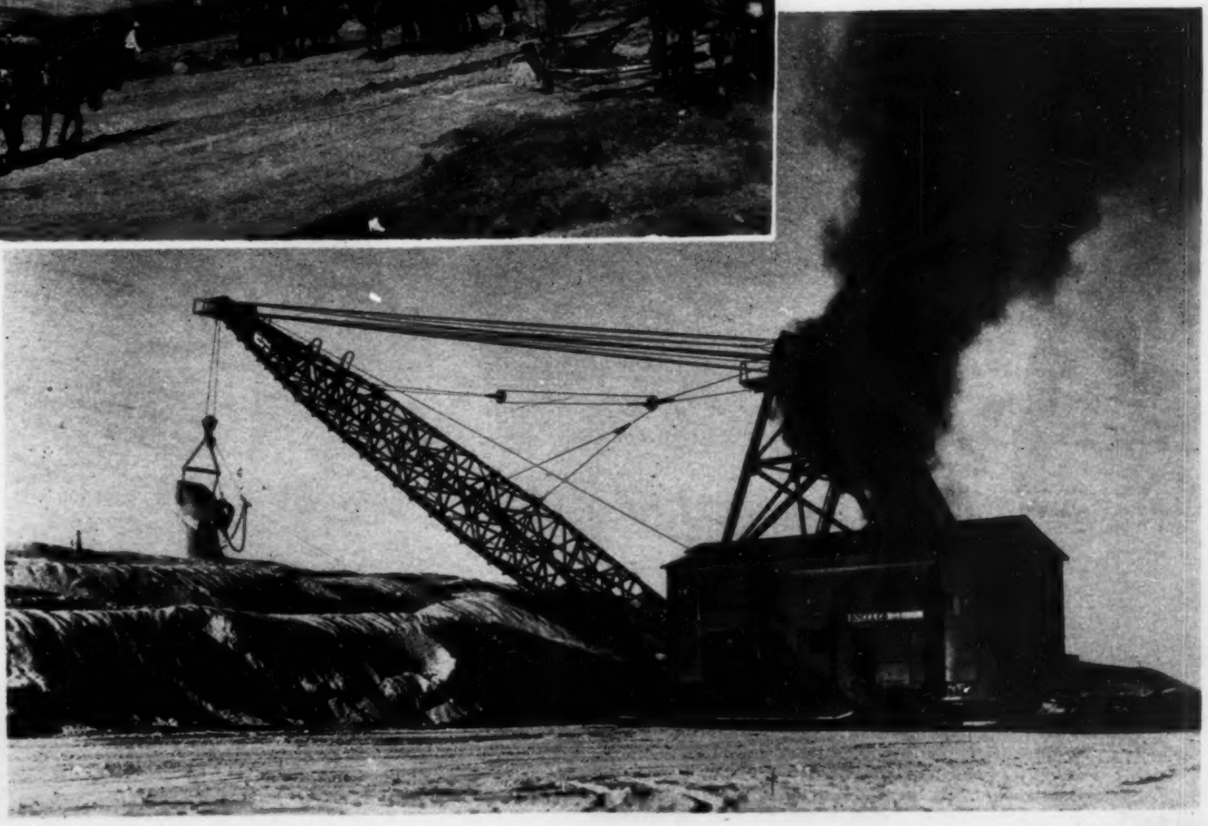
ROCK EXCAVATION on Griffith Co. contract is handled by Northwest power shovels loading 25-yd. Le Tourneau buggies hauled by Caterpillar tractors.

HORSE DRAWN FRESNO SCRAPERS are employed on one force-account section to provide emergency relief employment to residents of Imperial Valley.

Photos from

R. B. WILLIAMS

Construction Engineer, U. S. Bureau of Reclamation, Yuma, Ariz.

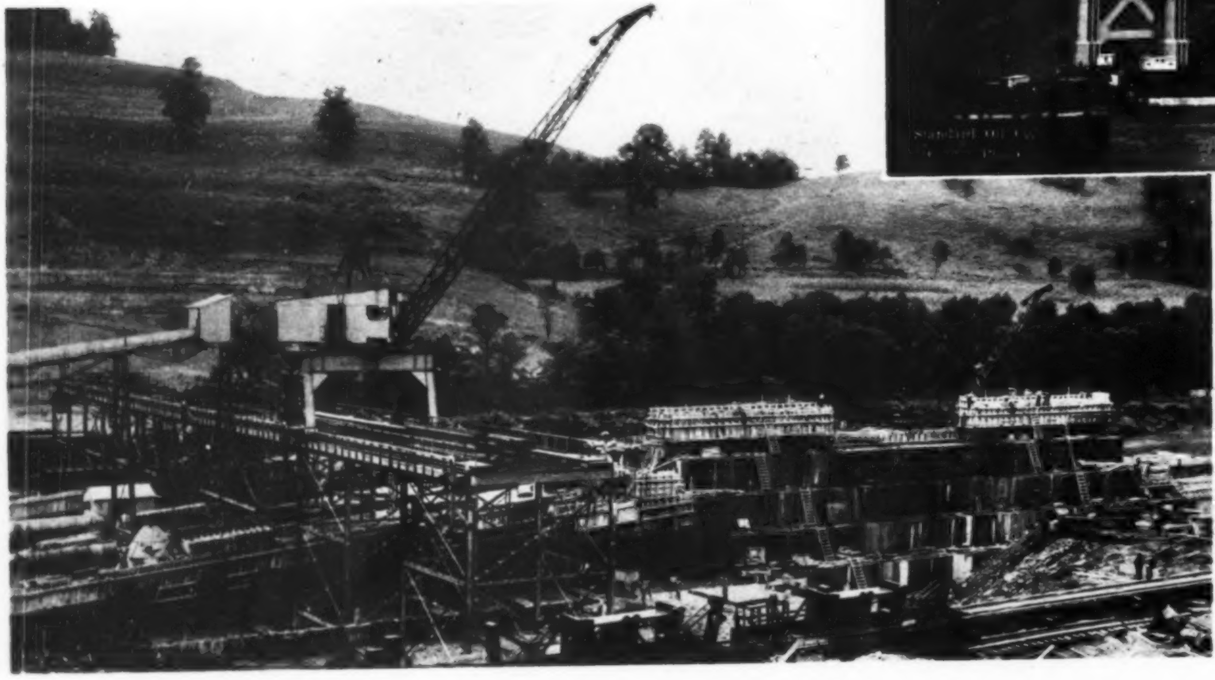


HUGE WALKING DRAGLINES of Bucyrus-Monighan type *(right)*, with 175-ft. booms and buckets up to 12-yd. capacity, are employed in sand-hill sections by Boyce & Igo and W. E. Callahan-Gunther & Shirley crews.

This Month's

"NEWS REEL"

CONCRETE PLACING BRIDGE *(below)* of structural steel, carrying full-revolving cranes handling 3-yd. buckets filled with concrete from hopper fed by belt conveyor is main construction feature of Tygart River dam under construction for Corps of Engineers, U. S. Army, by Frederick Snare Corp., contractor of New York. As described in detail elsewhere in this issue, concreting bridge will be extended in three lifts to ultimate height of 174.5 ft. and will remain embedded in completed structure, 232 ft. high and 1,850 ft. long, costing $6,305,773.



WORLD'S LONGEST CATWALK is completed as preliminary to spinning 36¼-in. diameter cables to support 4,200-ft. main span and two 1,125-ft. side spans of Golden Gate bridge, San Francisco. Cables and suspender are being placed by John A. Roebling's Sons Co. under $5,855,000 contract. Steel towers, extending 746 ft. above mean low water, have been completed by McClintic-Marshall Corp. under $10,494,000 contract which also includes floor system, bracing and anchorage appurtenances.

LONGEST SIPHON *(below)* on 242-mi. Colorado River aqueduct in California is 5-mi. Casa Loma structure being built as monolithic reinforced concrete tube by J. F. Shea Co., Inc., and the Griffith Co., contractors, of Los Angeles. Crane lowers to place built-up sections of circular steel reinforcement.

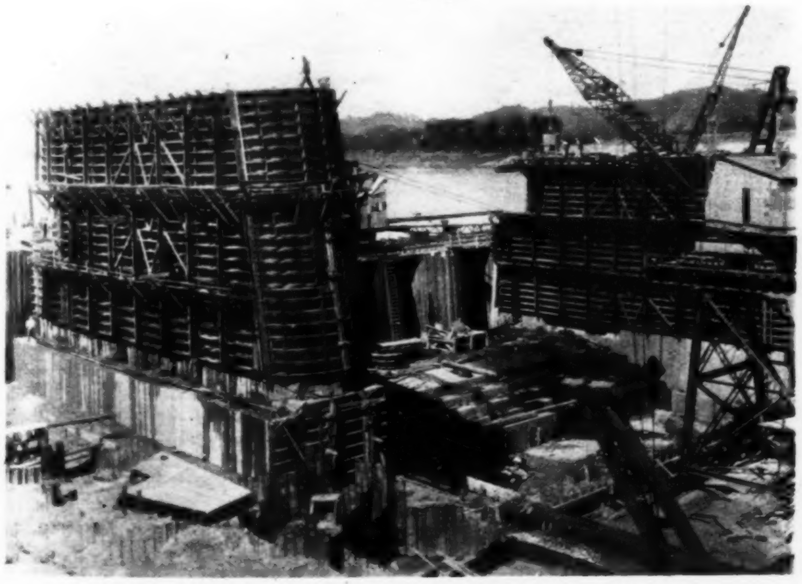
CONSTRUCTION IS RESUMED on San Gabriel Dam No. 1 in California after suspension Nov. 14, 1934 for modification of plans and specifications by Los Angeles County Flood Control District. Redesigned structure, world's largest rock fill, will have base widened from 900 to 1,800 ft. and will contain 9,000,000 cu.yd. of material instead of 5,000,000 cu. yd. originally planned. Height, 300 ft.; length along crest, 1,670 ft. Contractors, West Slope Construction Co. Benches in upper right background indicate quarry from which most of the fill will be obtained.

LOW-COST HOUSING becomes a reality as N. P. Severin Co., building contractor of Chicago, erects first unit of University project in Atlanta, Ga., with allotment of $2,500,000 under direction of PWA's Housing Division. Group of 2 and 3-story brick flats and row houses will provide living quarters for 675 negro families.

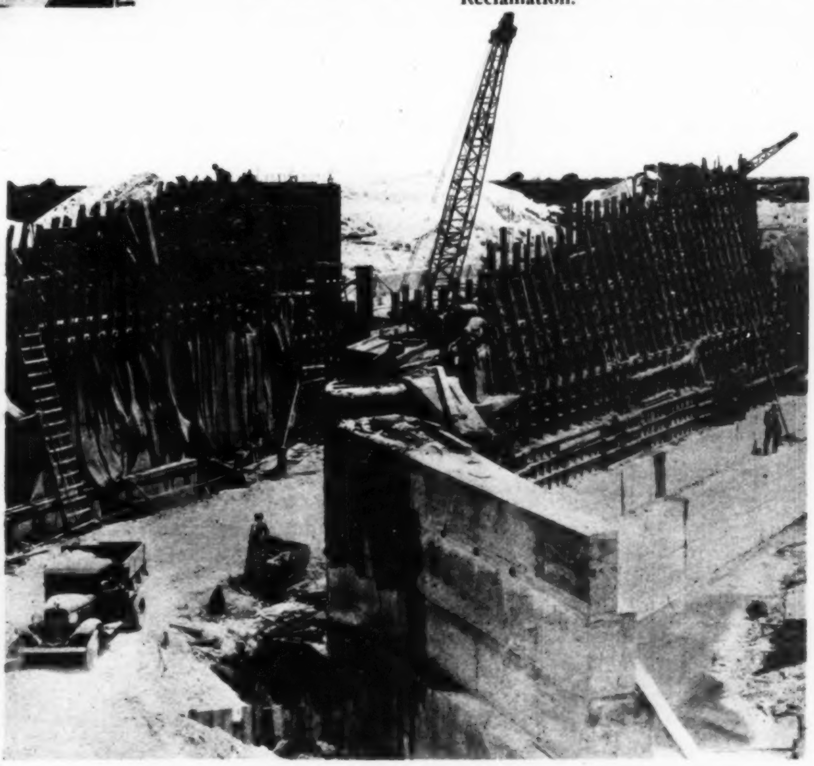
BELT CONVEYOR BRIDGE crossing Columbia River will deliver sand and gravel aggregates to concrete mixing plant of Mason-Walsh-Atkinson-Kier Co. at Grand Coulee dam. Cable suspension structure with central span of 1,437 ft., supported by tall steel towers, will be equipped with 36-in. belt having carrying capacity of 700 tons per hour on U. S. Bureau of Reclamation project.

Wide World Photo

THE PRESIDENT inspects a real construction job. On western trip last month Mr. Roosevelt at Boulder dam, has opportunity of comparing work of useful, permanent type with wasteful WPA projects on which large volume of Relief Act funds are being dissipated. With the President are his military aide, Col. Watson, and Walker R. Young, construction engineer in charge of Boulder dam for U. S. Bureau of Reclamation.



AT GALLIPOLIS LOCK AND DAM PROJECT on Ohio River in West Virginia (described in *Construction Methods* for May, 1935), Dravo Contracting Co., of Pittsburgh, is using whirler cranes and bottom-dump buckets for placing concrete in forms for piers and roller gate sills of dam. Structure, financed by PWA allotment, is being built within area inclosed by cofferdam of cellular steel sheet pile units, under direction of Corps of Engineers, U. S. Army, Major John F. Conklin, district engineer.



HURRICANE GATES are features of Florida's Lake Okeechobee project, involving 66½ mi. of levee for protection against flood tides caused by storms. Work under $7,700,000 PWA allotment is being done under direction of Corps of Engineers, U. S. Army (Lieut.-Col. B. C. Dunn, district engineer), as described in *Construction Methods* for August, 1934 and May and June, 1935.

FIRST OF A SERIES OF 10 ARTICLES...

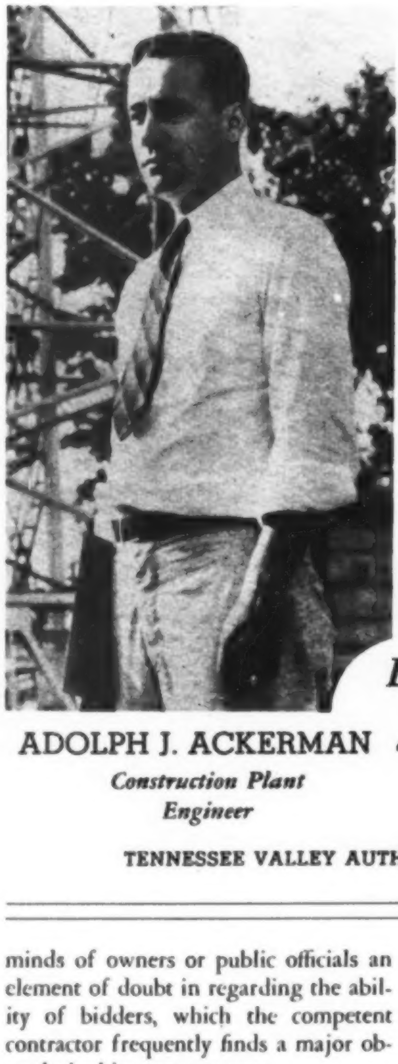
Planning and Plant for

HEAVY CONSTRUCTION

Principles and Practices of Job Layout and Selection and Use of Equipment for Large Dams and Appurtenant Works

...1...

General Problems and Preliminary Planning



By

ADOLPH J. ACKERMAN *and* CHARLES H. LOCHER

Construction Plant Engineer — *Construction Consultant*

TENNESSEE VALLEY AUTHORITY, KNOXVILLE, TENN.

HEAVY CONSTRUCTION in general covers a specialized field of large-scale work where plant layout and equipment are the primary factors in the execution of a job. Modern equipment has expanded the scope of such work to a point where it is now economically feasible to undertake projects which were only dreams a decade or two ago. While in some cases the ideal plant layout may be an ingenious combination of standard machines and equipment, recent experiences have shown that new designs and developments of special plant features frequently pay for themselves on a single job even though their first cost appears high.

General Problems

The current program of heavy construction in this country comes at a time when its effects are particularly widespread. While the remarkable achievements in this class of work are universally recognized, a clearer understanding of some of its problems is of primary importance. Summarized below are some of those problems that have a vital bearing upon heavy construction and its future development:

(1) *Gamble*—In this class of work experienced, competent and conservative construction service is at present offered by only a relatively small number of contractors. One need only look at recent bid sheets of major projects and observe bid variations of 50 to 100 per cent, to conclude that the job is considered a big gamble, a chance for a "killing," or that the low bidder doesn't know what it's all about. Such factors destroy confidence and breed in the minds of owners or public officials an element of doubt in regarding the ability of bidders, which the competent contractor frequently finds a major obstacle in his own progress.

(2) *Inexperience*—Because of lack of activity in their own field, an increasing number of contractors, inexperienced in heavy construction, are venturing into this work with inadequate background and with no conception whatever of what constitutes proper planning and plant layout for such work.

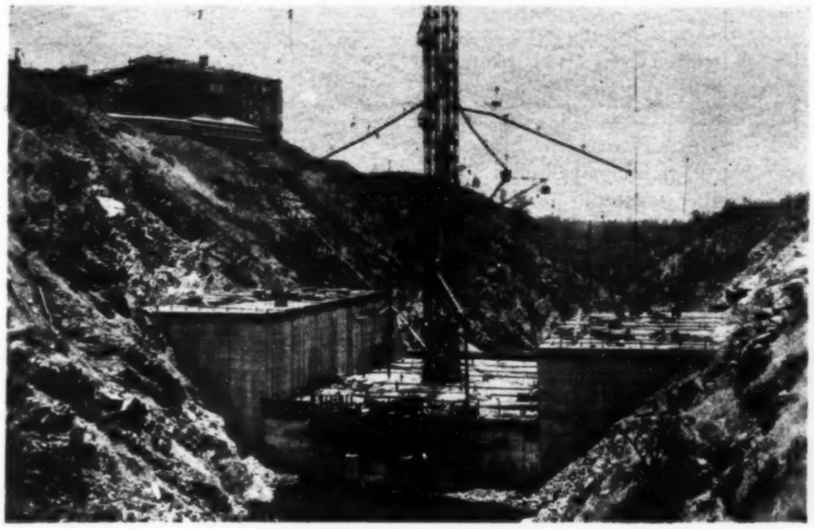
(3) *Financing* — The problems of financing heavy construction contracts have frequently resulted in several contracting firms forming a partnership to bid a job, thereby introducing complications in reconciling opinions with respect to construction plant and program.

(4) *Plant*—Many contractors, particularly when handicapped by partnership difficulties and financial limitations, fail at the outset to recognize the importance of adequate advance expenditures for plant and facilities that will produce the lowest final cost of the job. It is difficult to sell a contractor a plant for $600,000, on which another $150,000 would cover all maintenance, repair and lost-time expenses for the period of the job, as compared with selling him a $500,000 plant on which another $350,000 would go into such job expenses and extra labor. This is largely because such job expenses are not recognized in their true relationship except after first-hand experience.

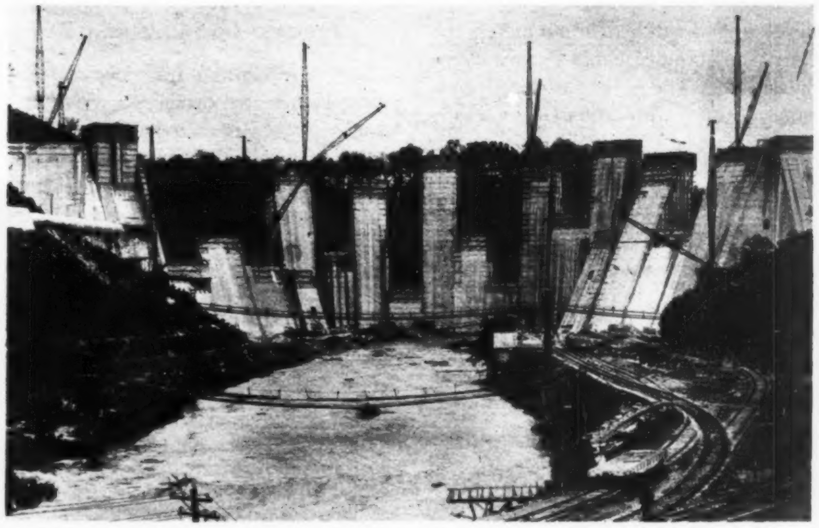
(5) *Equipment Selection* — Proper equipment selection is entirely a matter of first-hand construction experience. Some manufacturers have done an admirable job in working hand-in-hand with constructors in defining equipment requirements and, particularly, in developing special equipment. Others, under the stress of competition, have gone the limit in selling their standard line (usually more profitable) and where unwary purchasers have blindly accepted the claims and recommendations of the seller the ultimate results have, as a rule, been unhappy for both parties. Furthermore, progress in the construction art has thereby been retarded in a general way.

(6) *Manufacturers*—The competent and conscientious equipment manufacturer is a contractor's most important ally. Both are seeking—and are entitled to—a fair profit on their respective operations. Too often some equipment buyer delights in forcing the maker to knock off another 5 or 10 per cent, or he accepts a cheaper competitive article, with the usual result that before the job is ended 10 or 20 times the difference has trickled away. Unfair policies of price and long-term financing on equipment purchases are considered by some contractors all right in one direction, but when similar policies are proposed to them on their own work they usually protest with a great display of injured feeling. On the other hand, some seller will occasionally volunteer such inducements just to get the order; this practice, obviously, is equally poor business. There is no substitute for good equipment; sound development in this field means greater progress in the construction industry as a whole.

(7) *Engineers*—Many engineers in their trend of thought and design are out of step with the art of heavy con-



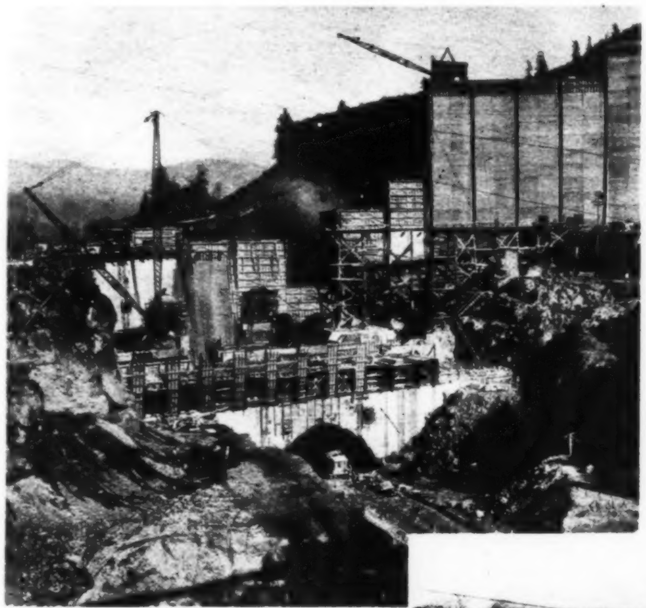
ELEVATOR TOWER AND CHUTES—Pardee dam, Mokelumne project, California.



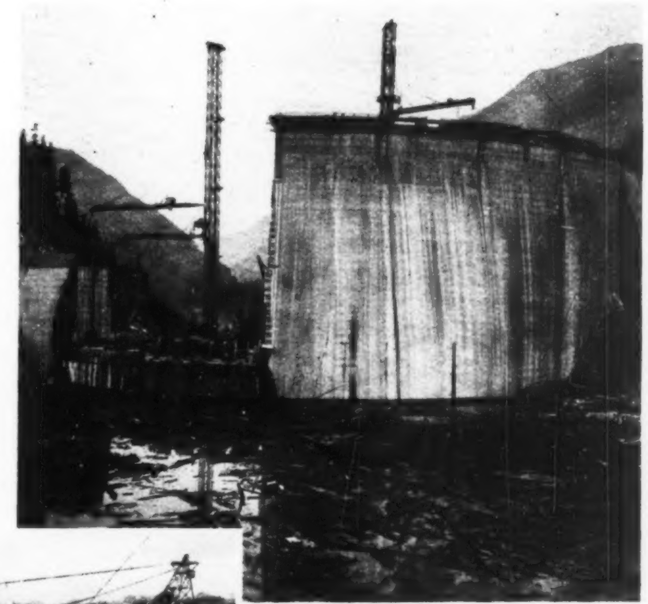
GUY DERRICKS—Santeetlah dam for Aluminum Co. of America, North Carolina.

SIX METHODS OF DAM CONSTRUCTION

Builders chose distinctly different equipment for structures similar in size, type and general characterstics.

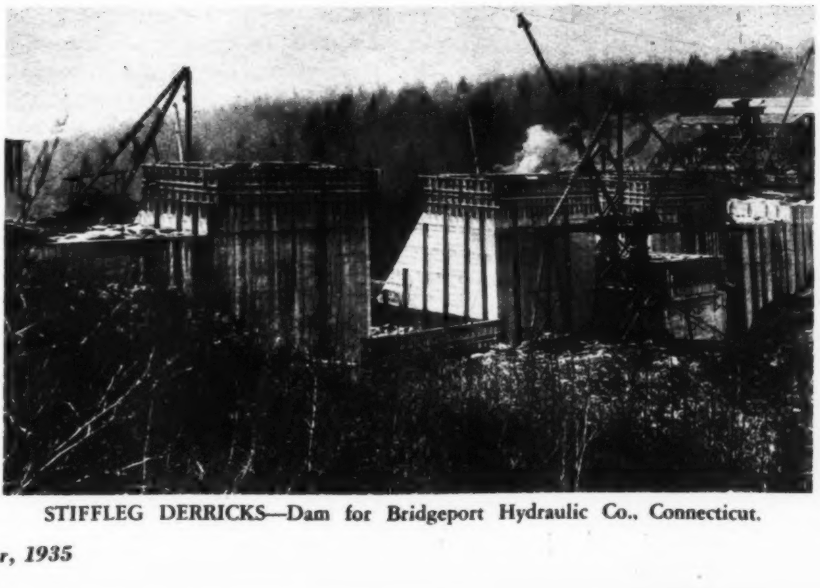


WHIRLER CRANES—Ariel dam for Phoenix Utility Co., Washington.



ELEVATORS AND BELT CONVEYORS—Diablo dam for City of Seattle, Wash.

CABLEWAY—Madden dam for Panama Canal, Canal Zone.



STIFFLEG DERRICKS—Dam for Bridgeport Hydraulic Co., Connecticut.

struction. This applies not only to some designers of large projects, but also to many engineers who attempt to sell their services to contractors. The complaint is often made that most engineers fail to think in terms of construction and, as a result, contractors have frequently attempted to get along without technical advice. Planning for heavy construction involves a large amount of engineering, and competent and practical engineering service is a vital part of a modern contractor's organization.

(8) *Risks*—Heavy construction involves tremendous risks not only from physical damage, during construction, floods, fire, breakdowns, weather, subsidence and sabotage, but also in price changes in material, machinery and labor markets. One old contractor was in the habit of calling his business a combination construction and insurance underwriting venture. In many cases the risk or insurance phase of a job runs high, and it is reasonable that the contractor be rewarded in proportion to the risks which the owner or public agency expects him to assume. This phase, however, is often abused either by an unfair attitude towards honest contractors or by a variety of dishonest practices on the part of unscrupulous contractors. Under the guise of adequate reward for heavy construction risks, political graft has entered into some large public projects. This may develop in the most unsuspected ways: Some time ago a reputable contractor was low bidder on a large public sewer job, but award of the contract was mysteriously withheld until he was approached by an individual who offered to sell him for $25,000 "expert advice" on how to secure the contract. The plot collapsed when the contractor publicly offered to increase his bond by 50 per cent to dispel any doubts regarding the award of the contract to him. Heavy construction must be freed of any popular notions that it may tie in with graft or corruption; the building up of confidence is one of the most important phases of planning.

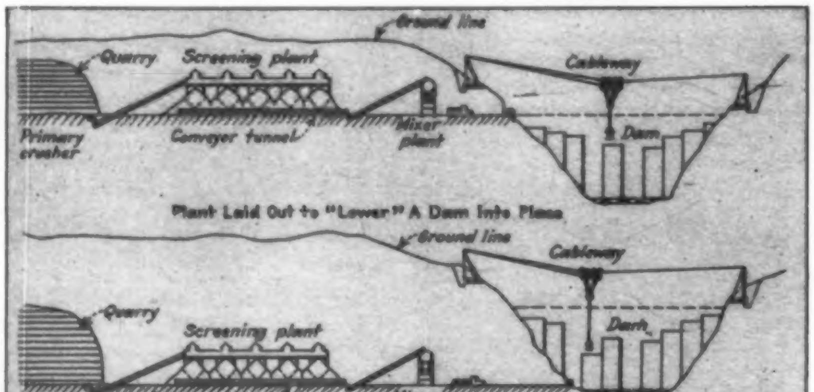
Mechanization—The future of heavy construction will depend largely on new developments in plant and procedure which will spell lower costs. The consequent increase in volume and extension of new frontiers in engineering

development will benefit not merely the construction industry, but also the country at large. The benefit of mechanization is not readily apparent or easily demonstrated by examples in the construction field. The accompanying diagram, however, indicates definitely to what extent mechanization has benefitted the country at large. This diagram, taken from the business bulletin of the Cleveland Trust Co. for March 1935,

"The competent and conscientious equipment manufacturer is a contractor's most important ally. Both are seeking—and are entitled to—a fair profit on their respective operations."

was made on the basis of taking each factor as equal to 100 in the year 1870. During the past 60 years the installed horsepower in American factories increased 18.3 times. During the same period population increased 3.19 times, while the number of persons gainfully occupied increased 4.09 times. In other words, in spite of tremendous growth in installed power in factories during the past 60 years, the number of people gainfully employed has increased one-third faster than the population itself has increased.

It is hoped that the present series of articles will help to stimulate a greater appreciation of the achievements and vital importance of heavy construction. Individual articles in this series will cover special phases of its make-up. While there are many specialized fields in this class of construction which cannot be adequately covered in the present series, most of the important construction operations will be covered by centering discussion upon large dam projects with power and irrigation appurtenances in order to provide logical continuity and relationship.



"HOISTING" AND "LOWERING" a dam into place. These sketches illustrate an important principle of plant layout. Lowering is cheaper and faster than hoisting when placing concrete in a dam. Where topography requires the quarry and aggregate storage to be located at approximately normal river level it is generally better to elevate the raw materials by means of a belt conveyor to an upper mixing plant so located as to permit delivery of concrete to the main dam somewhere within the upper half of its total height.

Preliminary Planning

Most big jobs last from two to four years. The degree of success which attends such jobs is directly proportional to the ability which has been employed in accurately predicting the many conditions and contingencies which may develop over such a long period of time. From a contractor's standpoint, the two most critical periods of a job are, first, when he decides to bid a job and makes a detailed preliminary analysis, and, second, having been awarded the job, when he sets up his plant and thereby fixes once and for all most of the important construction procedures. We shall first discuss briefly the importance of preliminary studies which, in general, precede the filing of a bid or actual moving in on a job.

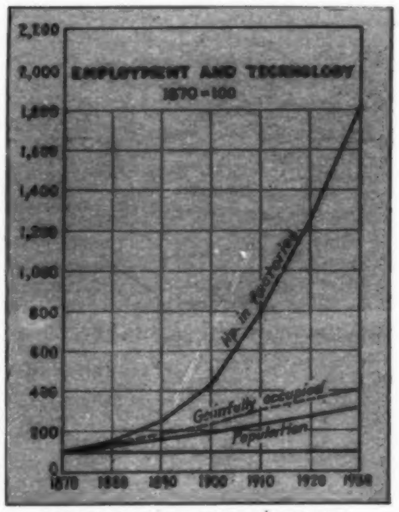
MODEL (*below and in oval*) of special 6-yd. concrete bucket for cableway service. The problem here was to develop a bucket which could discharge a very dry mixture of concrete. This required a full bottom opening. At the same time it was essential to discharge the concrete without excessive rebound of the cableway bucket.

Number one rule is, obviously: *Study the specifications*. The very simplicity of this rule may invite indifference, but the word "study" is an extremely important one. It is impossible to write a perfect specification, and unless a contractor thoroughly understands their *intent* as to *what* he is to build and under *what limitations*, he can hardly make an intelligent analysis of *how* he is going to do the job.

The second rule is: *Study the job*. This means chiefly the physical conditions and related factors which have an important bearing upon construction procedure.

Topography—On a large dam project the topography of the site is one of the controlling factors in determining the construction procedure. A canyon site would in all probability call for a cableway layout, whereas a long low-head dam in a flat river valley would probably require a construction bridge and cranes. Topographic conditions will largely govern the location of suitable foundations for screening plant, mixer plant, cableways, access roads and miscellaneous plant buildings. In a flat valley these problems are generally not serious, but in a canyon site they may take on primary importance. Frequently it is possible to start a job by excavating for the foundation of the dam and spoiling the earth and rock into adjacent areas so as to develop a well-graded space on which construction plant buildings can be erected.

Geology of Site—A study of geological conditions at the site is of equal importance. Where manufactured aggregate is to be used, the selection of the



EMPLOYMENT AND TECHNOLOGY. Diagram by Cleveland Trust Co. shows increase in number of people gainfully employed in spite of tremendous increase in installed power factories during last 60 years. Employment increases at rate one-third faster than population growth.

most suitable quarry site definitely ties down the plant layout and defines one of the principal construction costs.

The records of foundation explorations and borings for the main dam should be carefully inspected, and it is important to know how they were obtained so that check calculations can be made of the different classes of excavations. An intelligent selection of the most suitable and economical excavating equipment cannot be made if there are possibilities of extended overruns or underruns in the different kinds of materials, such as earth and rock.

In general a dam is designed to use as far as possible the prevailing natural materials of the region. Before a constructor can adequately determine how these materials are to be handled he must know the nature and location of their deposits. Can the excavation from the dam be used for concrete aggre-

"Many contractors fail at the outset to recognize the importance of adequate advance expenditures for plant and facilities that will produce the lowest final cost of the job."

gate? If earth dams are to be built, is the material sandy or full of clay? How will it handle? What kind of equipment should be used? In the case of rock for rock fills, how will it break? How will the equipment stand up? What size of equipment is needed? Over what kind of surfaces must it travel? These are only a few of the many questions which must be answered by a careful exploration of the site.

Climatic Conditions — The effect of weather on construction is full of uncertainties and at the same time is one of the most important factors in select-

ing the most suitable equipment for the job. Extensive rains may have an important bearing upon the selection of hauling equipment, such as trucks versus tractors. A job came up recently requiring about two million yards of rolled earth fill for a dam. This type of dam was selected because the natural deposit of material at the site was almost ideally suited for a rolled fill. However, upon further consideration of the rainfall conditions in the region, it became evident that the work might be repeatedly shut down because of the probability that excessive moisture would prevent proper rolling and compacting of the material. It was subsequently agreed to build a hydraulic fill dam and employ a dredge instead of rolling equipment. The results were highly satisfactory, shut downs due to rains were eliminated.

In colder climates the technique of winter construction requires special consideration. A large construction job which is up for consideration attracts contractors and builders from all parts of the country and one or two of them may have seen the region and the site of the job for the first time. If the stage of the river at that time is used as a basis for sizing up the job, succeeding experiences may be very unhappy, as has been demonstrated time and again.

Labor Market—There is the further study of the labor market. For this purpose it is very desirable to have the prospective superintendent in charge of construction available so that he may assist in analyzing labor conditions of the region, because this relates to one of his primary responsibilities throughout the period of construction. He will need a large number of skilled carpenters, especially at the beginning of the job, for building camp and other buildings. Mechanics will be in demand, as will common labor, and it is desirable to study what effects a large construction job will have upon present industries in the region. Wage rates must be carefully analyzed on a basis of fairness and with a view to maintaining a satisfactory stability of labor conditions in the region.

Housing Facilities — The housing facilities near the site of the work must be studied to determine adequate accommodations for the first contingent of workers and in deciding as to how much camp to build for supervisors and for such classes of workmen as are not obtainable from the region. A reasonable consideration of these factors can dispel considerable exploitation at the expense of the constructor's prospective employees. During construction it is important to maintain adequate policing and health service and to assist in preventing the growth of undesirable areas of "squatters" in the vicinity of the job.

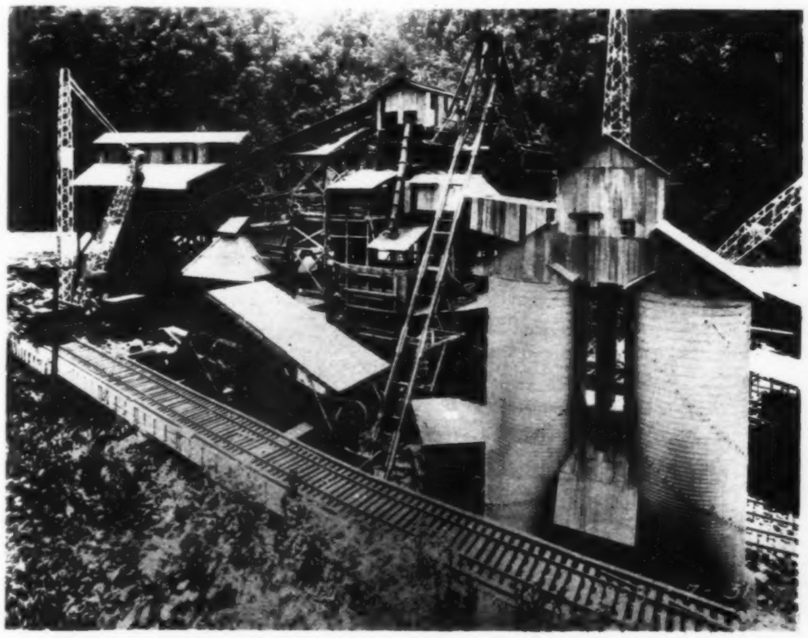
Public Relations—When a constructor is about to enter a new region a cooperative spirit toward community officials and civic leaders of the region is not only essential for maintaining a reasonable stability for the residents of the region, but he will also materially benefit his own work and his own personnel if he enjoys their good-will. A contractor on a big job immediately becomes a very influential factor in the region by virtue of the large expenditures which he makes. If he starts right by dealing with local markets for small requirements, helps with civic problems, and displays a spirit of fair dealing in the use of local labor, he is building up a definite source of profitable return. Such local support may at times keep him out of serious legal entanglements. Recently an out-of-town contractor needed a large storage space along a river for bringing in his sand and gravel only to find that all of the most suitable sites had been optioned by a competitor, who, having failed to land the job, still expected to "clean up" by selling his option to the successful bidder. It so happened that the city owned a satisfactory site and by cooperatively working out a plan for employing local labor, making local purchases and assisting with other community benefits, the contractor won the good will of the local people and obtained the site at a very moderate cost.

A builder's responsibility is not only limited to the period of construction but extends many years into the future. There is much to be gained in leaving behind a good reputation, which, in the long run, is bound to pay big returns. Every large project creates a new monument of permanent value to the region and instead of temporarily creating a boom town which is left behind entirely dead and in a lifeless region the members of the community should have gained, and are entitled to, a better state of living and citizenship.

Analysis of Plant Layout—The subject of plant layout will be discussed in considerable detail in succeeding chapters. However, as part of a preliminary study of a project, it is important that all of the primary factors which go to make up a plant layout are recognized in their true relationship. As already stated, the site and natural topography definitely determine certain types of plants, whether they be of the type involving transportation by air, such as cableways, or on ground, or on water. As a rule, the materials handling equipment is required to perform a large variety of functions in building a dam and the selected layout must be able to do all that is required of it.

The size of the plant is of primary importance, and while there would be a natural tendency to underplant a job, particularly where a contractor is required to buy all new equipment, there is a very definite danger of overplanting a job where a contractor has a large amount of used equipment standing idle which he feels should all be earning money for him. Every job has a certain "best rate" of production. Either a slower or a faster schedule means higher costs and reduced profits. Certain requirements of the specifications may also affect the rate, and, at

QUARRY SITE at Calderwood dam, in Tennessee, showing highly fractured rock formations, which means lower cost of blasting. Location of quarry with respect to dam has important bearing on plant layout.



OLD STYLE of crushing, screening and concrete mixing plant for dam construction. Timber construction used almost exclusively. Note type of wood-stave cement silos in lower right corner.

MODERN ALL-STEEL screening and concrete mixing plant as installed at Madden dam in Panama. This type of structure is fireproof, dependable in operation and low in operating and maintenance cost.

the same time, progress of the work must tie in generally with the river stages during construction, with proper regard for flood seasons.

Power supply, source of fresh water, source of raw water for concrete mixing, and similar factors require proper analysis.

As a general rule, it is possible to make comparisons with current or previous similar projects as a guide for analyzing a new site. Such elements as excavating procedure, concrete handling, dredging, or making sand from rock, require careful consideration in the light of past experience. At the same time, every job demands painstaking study of all proposed operations in order to determine how to do the required work for the least expenditure of money. The remarkable construction record made on Boulder dam emphasizes the high degree of vision and skill employed in correctly analyzing a difficult job of unprecedented magnitude, and in developing an equipment and plant layout in terms of size and output, which, up to that time, were entirely unknown.

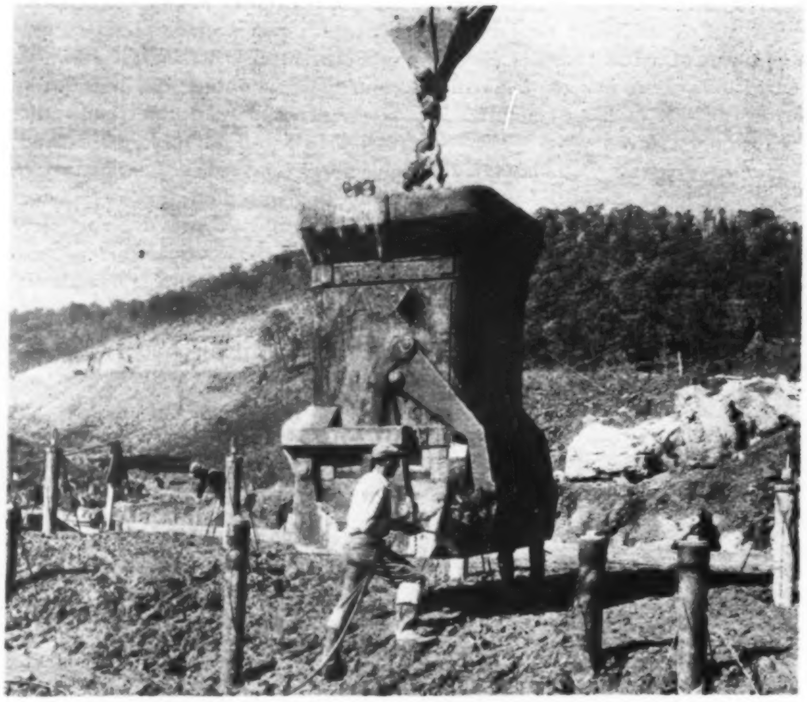
In laying out a plant, many principles must be considered which will be discussed in detail in succeeding chapters. However, as a general thing, it is desirable to make a layout which as the work goes on, tends to systematize itself. It is a very expensive job

"The future of heavy construction will depend largely on new developments in plant and procedure which spell lower costs."

to teach 2,000 to 4,000 men how to keep their work going in the most economical manner for the project as a whole. Where the equipment functions so as to permit everyone to become familiar with its purposes, there is a natural "catching on" on the part of every man on the job, which helps to keep the ball rolling. As a rule, the first cost of a plant is a relatively small element of the total cost of doing the job. The day-to-day costs are what count and where these can be reduced by a more expensive plant within reasonable limits such opportunities should not be overlooked.

Once the plant is designed and built, the entire job is practically fixed. If the plant is right, the job is as good as built. If wrong, it costs more to change, as a general rule, than can be saved. Errors in any selection of plant or equipment not only retard construction progress in general but also lower the morale on the entire job.

One important principle that will be stated here at the outset and may not occur frequently enough hereafter



FULL-SIZE BUCKET of 6-cu.yd. capacity, as finally designed for Norris dam cableway, following tests of model bucket illustrated on preceding page. Bucket, with various improvements made under actual operating conditions, has operated satisfactorily in all respects

to retain its importance in the mind of the reader is this: Special equipment (the primary topic of these articles) is an essential part of heavy construction, but on every individual job there are opportunites for employing standard equipment or even hand labor for maximum economy. Careful planning and experienced judgment will keep these methods in proper balance.

Models of Construction Layout and Equipment—Frequently a small model of a device or of a plant layout will serve as a valuable check of a paper study, or will often bring out elements that have previously been overlooked. Such questions as river handling and cofferdam problems require a thorough analysis of step-by-step procedure, and if these steps are first carried out on models, many potential mistakes will be disclosed and prevented on the full-scale work. Similarly, models of special pieces of equipment will provide valuable information and, in any case, reassurance before any large expenditures are made on full-scale operation that the proposed scheme will work satisfactorily.

On a recent job there was a rather difficult piece of excavation work required within a constricted cofferdam area. The excavating and hauling equipment had certain limitations of reach and maneuverability. It was necessary first to uncover certain foundation areas so as to permit concreting to start without further delay. At the same time, it was necessary to maintain ramps around the exposed foundations so that, as the excavation went down, there was always an opportunity to get out with the hauling equipment and finally with the excavators and shovels. By building a model of the cofferdam area and using sand to represent the required excavation material, three or four different proposed methods were studied, but the most satisfactory one was a new one which was developed on this model. By bringing in the foremen and shovel operators and showing them the intended procedure, every one understood thoroughly what was proposed and the cost of the model was saved many times over.

At Norris dam artificial aggregate and requirements for a relatively dry mix called for concrete which was rather difficult to handle in large batches with standard commercial concrete buckets particularly for service on cableways. Various special buckets were designed and the best type was finally built on a small scale and tried out. This disclosed a number of points which required improvement and was a big help in arriving at a satisfactory solution of the problem.

Coordinating Design and Selection of Plant—A great deal of money can be saved if the builder and the engineer become acquainted with each other during the early stages of the job planning. Specification requirements can frequently be cleared up so as to save the builder a lot of unnecessary worry. The construction man, as a rule, also has some valuable experiences to contribute to the job, and if these are properly worked out with the engineer, the results may be a more satisfactory piece of work for the owner and considerably less difficulties for the builder. Some of the more common questions which occur on practically every job are: The height of lift and location of construction joints; substituting laps for unnecessarily long reinforcing bars which seriously interfere with

"Study the specifications! The very simplicity of this rule may invite indifference, but the word "study" is an extremely important one."

handling of concrete; boxing out for gate guides and similar structural steel which can be more satisfactorily installed after the heavy part of the structure is completed; permissible changes in sequence of starting various sections of the work can often lead to important economies.

Summary—To summarize, if the preliminary studies have been carried out in a thorough manner the builder can determine his costs with greater confidence, and ultimate success is envisioned more distinctly right from the start. Furthermore, he can proceed with a well-defined plan the day he is notified and may gain a season of construction, beat the floods or rains or have everything in readiness when the most opportune starting time breaks.

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NEXT MONTH—Chapter 2 of the series on "Heavy Construction"; by A. J. Ackerman and Charles H. Locher, to appear in the December issue, will deal with "Preparatory Work—Access to Job, Camp and Shops."

CHAPTER SUBJECTS OF ACKERMAN-LOCHER SERIES ON

HEAVY CONSTRUCTION

1 ... General Problems—Preliminary Planning
2 ... Preparatory Work—Access to Job, Camp and Shops
3 ... Schedules and Equipment Selection
4 ... Cofferdams, Control and Diversion of Rivers
5 ... Excavating Equipment
6 ... Foundation Preparation — Drilling, Blasting, Grouting
7 ... Transportation Equipment
8 ... Concrete Aggregates, Cement, Water
9 ... Mixing and Placing Concrete
10 ... Canals, Tunnels and Penstocks

TUNNEL HAULAGE Made Safe by Unceasing Vigilance

By FLOYD T. HUNTINGTON

General Superintendent, Walsh Construction Co.

● An address (slightly condensed) before the Contractors' Executive Safety Committee of the Colorado River aqueduct in California.

FLOYD T. HUNTINGTON is in charge of driving 9½ mi. of 16-ft.-diameter tunnels for Walsh Construction Co. on Colorado River aqueduct.

SHIFT GOING INTO TUNNEL. Man cars are coupled behind 8-ton locomotive equipped for trolley and storage-battery operation.

TUNNEL transportation is one of the major sources of underground accidents and probably constitutes as great a hazard as any underground operation. The principal causes of underground transportation accidents are: (1) Improper operation (due to carelessness, negligence, or ignorance of operators); (2) defective track; (3) defective trolley equipment; (4) defective rolling equipment.

Accidents attributable to the first of these causes can largely be eliminated by the use of operators who have had a year or more of tunneling experience. This experience implies a familiarity with underground transportation and a knowledge of safety requirements. In addition, it is my opinion that only the younger experienced men should be used as motormen and brakemen. Tunnel transportation involving the operation of locomotives and trains is not an old man's job. It requires a quickness and alertness which a great many men over, say, 40 years of age, or even less, do not possess.

Motormen and brakemen should be made familiar with the rules and regulations for safe operation. At the Walsh Construction Co. tunnels, the following rules are given to all motormen and brakemen to sign, and copies are posted conspicuously so that all employees may be familiar with them:

1 Motormen shall be responsible for the safe operation of motors and trains.

2 Brakemen shall ride on head ends of all trains and shall have their hand lanterns and whistles with them to signal the motormen.

3 Lights shall be displayed at both head and rear ends of trains, and no train shall be moved without the necessary lights.

4 A safe speed shall be maintained under all circumstances. At switches and curves the speed shall not exceed five (5) mi. per hour.

5 The powder car shall be pulled behind the motor at all times. The motorman shall refuse to take any passengers when hauling an explosives car, with the exception of the brakeman and/or helper. The trolley pole shall be down and the motor shall be operated on battery when the motor is coupled to powder car.

6 Men, in groups when going on shift, shall be transported in man-cars only, or seated inside of muck cars. The same rule applies to groups of men coming off shift. Any car carrying men shall be pulled, at all times, by the locomotive, and speed shall not exceed eight (8) m.p.h. on straight track and five (5) m.p.h. on curves and at switches.

7 No one shall be allowed to ride on the head end or top of locomotive with the exception of motormen and brakemen.

8 Only three men shall be allowed to ride at one time on rear step of locomotive.

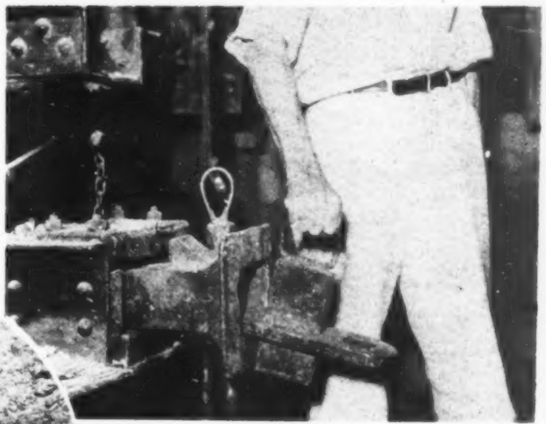
9 Motormen shall operate motors from motorman's platform. Under no circumstances shall a motorman leave his motor while it is in motion, nor shall motorman start his motor while he is standing on the ground, or on the outside step, or on drawbar.

10 Motormen shall not run motors under the ramps on car passers until safety dogs are set in place.

11 Superintendents and tunnel walkers will be allowed to ride on any and all trains at any and all times.

Photos by Metropolitan Water District of Southern California

COMBINATION POWDER AND PRIMER CAR always is pulled behind locomotive.



SAFETY COUPLER is used if cars are not equipped for automatic-coupling, which is preferred both for safety and efficiency.

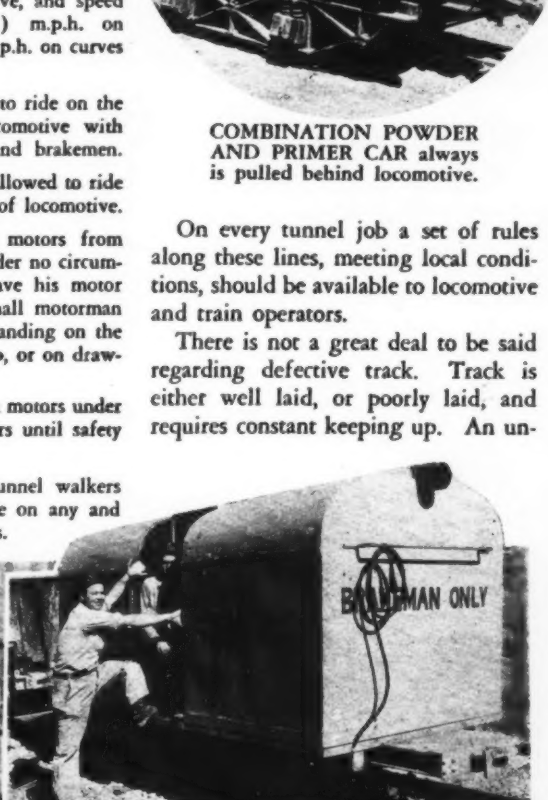
On every tunnel job a set of rules along these lines, meeting local conditions, should be available to locomotive and train operators.

There is not a great deal to be said regarding defective track. Track is either well laid, or poorly laid, and requires constant keeping up. An uneven track, with poor rail joints and poor bed, haphazardly installed, and with angular curves and insecure switches, is an invitation to disaster.

Rolling equipment is subjected to constant wear and tear and, if not maintained in good order, will be a continual source of accidents. Flat wheels may cause a train to be derailed at any speed.

In general, constant supervision by superintendents, tunnel walkers and shift bosses is necessary to safe and satisfactory transportation, and this supervision involves continual education of motormen, brakemen and all employees having to do with transportation equipment and haulage. Local conditions determine specific requirements, but general safety measures which apply to almost all tunnel work are: The placing of guard rails at the operating ends of locomotives as a protection to motormen; the furnishing of safety-type handles to brakemen for making couplings where automatic couplings are not used; an adequate system of signal lights, particularly at wyes; and the painting of the ends of locomotives white to obtain greater visibility It requires the personal and continual watchfulness of those in charge to enforce safety measures and avoid accidents.

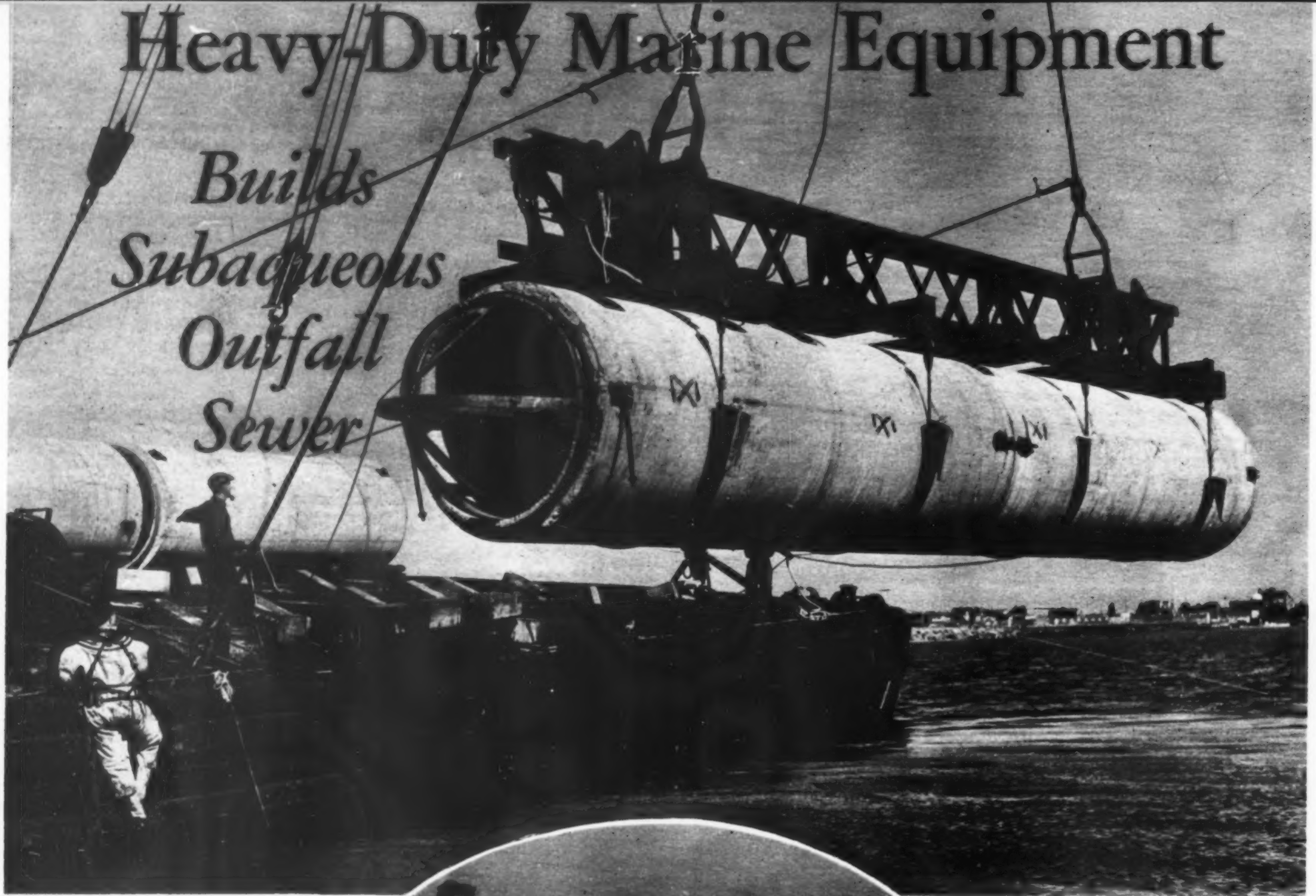
WELL-LAID TRACK *(below)* assures freedom from train derailments caused by uneven joints, angular curves, and unsteady roadbed. Note wood blocks at switch frogs and guard rails.



MAN CAR is designed to provide safe transportation for workmen going on and off tunnel shifts.

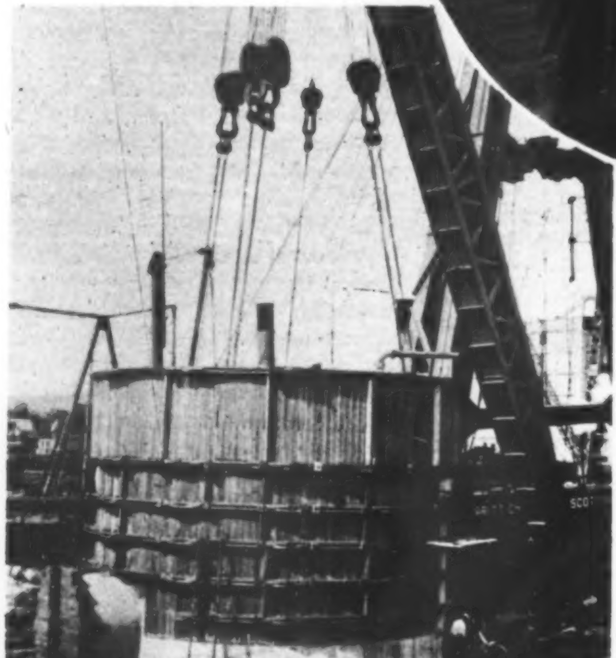
Heavy-Duty Marine Equipment

Builds Subaqueous Outfall Sewer



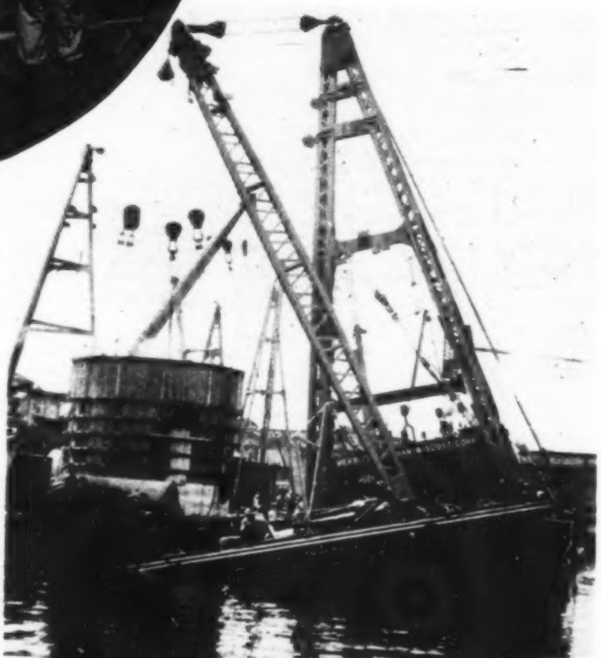
48-FT. LENGTH OF 72-IN. PRECAST PIPE, made up of two 24-ft. sections, is suspended from structural steel strong-back, ready to be lowered to bottom of bay and connected to portion of sewer previously laid. Collapsible steel pilot nose in near end of pipe will aid diver in guiding this unit into contact with pipe already in position. Bolts hanging from swivel lugs at two sides of pipe will be used to draw up tight joint under water.

IN CHARGE OF SEWER CONSTRUCTION. *(Left to right)* A. J. Williams, engineering assistant, and A. R. Glock, resident engineer, Department of Sanitation; C. B. Christiansen, construction superintendent, Merritt-Chapman & Scott Corp., and Frank D. Nantista and William Bailey, inspectors, Department of Sanitation.

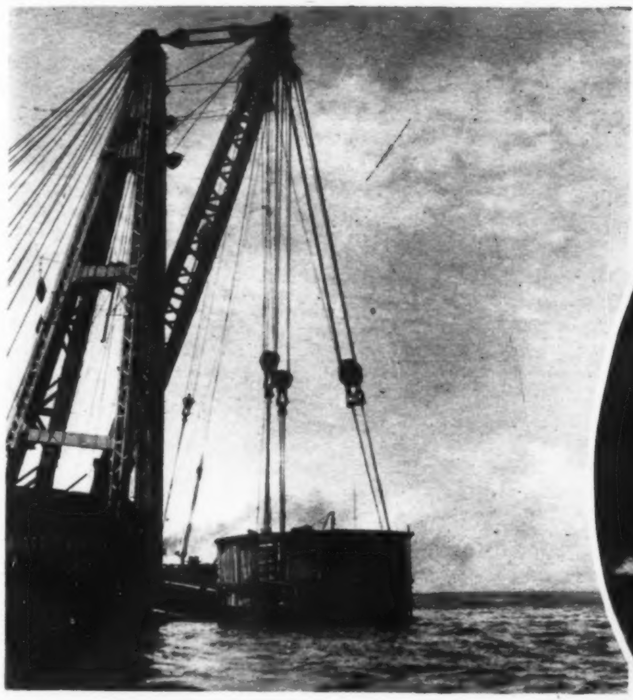


ON WHARF AT STATEN ISLAND, concrete chamber is built up to height of 11 ft. and is bulkheaded for further concreting after being launched.

LARGE-CAPACITY floating plant of the Merritt-Chapman & Scott Corp., of New York City, contractor, facilitated construction of the underwater portion of a 72-in. outfall sewer 1½mi. in length from the new Coney Island sewage treatment works for the Department of Sanitation of the City of New York. In constructing the underwater outlet chamber for the sewer, the contractor preferred to precast the chamber, of circular-well design, in the corporation's yard at Rosebank, Staten Island, and to tow the bulkheaded structure to position for sinking in the mouth of Jamaica Bay, on the south shore of Long Island. After the 4-ft.-thick walls of the circular chamber, 28 ft. in outside diameter, had been built up on the warf to a height of about 11 ft. and a timber bulkhead for flotation had been constructed in the bottom of the well against a backing

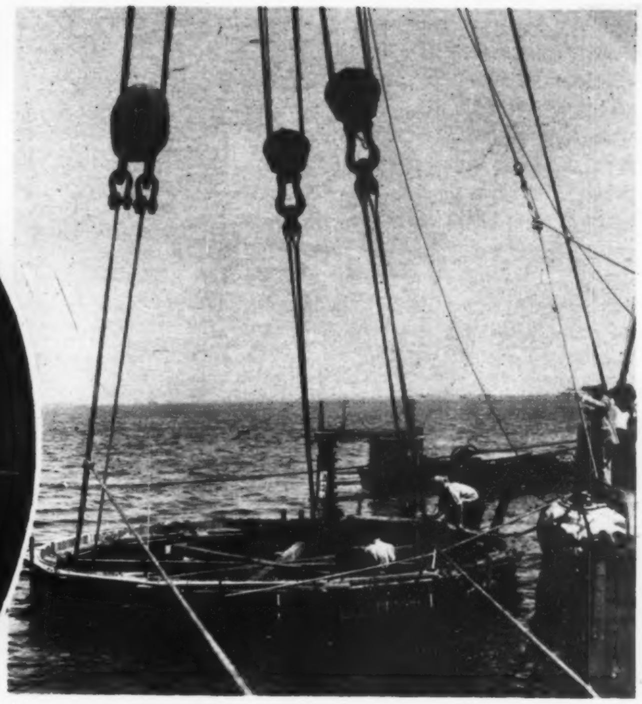


WEIGHING 250 TONS, bulkheaded chamber is picked up by large-capacity floating derrick and placed in water for addition of another concrete lift.

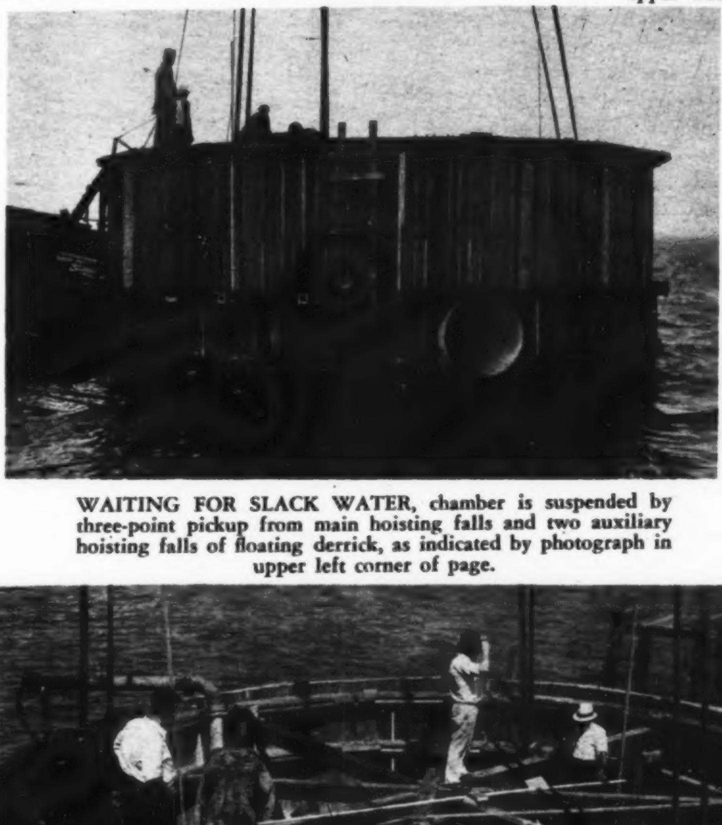


AFTER BEING TOWED to position in mouth of Jamaica Bay, floating chamber again is picked up by marine derrick preparatory to being lowered on to foundation piles.

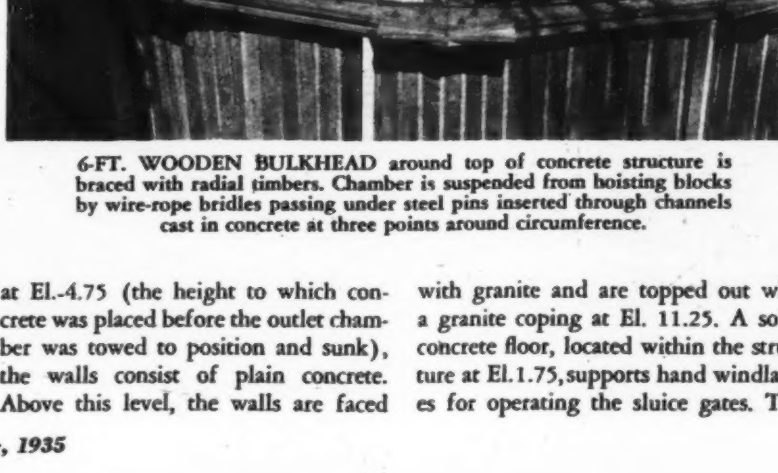
DURING SINKING OF CHAMBER *(below)* divers make several inspection trips to bottom to report on position of concrete structure in relation to foundation piles.



LOWERED TO FINAL POSITION in 1 hr. by admitting water and slacking off on hoisting falls, outlet chamber rests on timber foundation piles with top of upper wooden bulkhead extending about 1 ft. above high tide level.



WAITING FOR SLACK WATER, chamber is suspended by three-point pickup from main hoisting falls and two auxiliary hoisting falls of floating derrick, as indicated by photograph in upper left corner of page.



6-FT. WOODEN BULKHEAD around top of concrete structure is braced with radial timbers. Chamber is suspended from hoisting blocks by wire-rope bridles passing under steel pins inserted through channels cast in concrete at three points around circumference.

of grillage I-beams cast in the concrete walls, the 350-ton-capacity floating derrick "Monarch," of the Merritt-Chapman & Scott fleet, picked up the structure, weighing 250 tons, with a horizontal reach of about 50 ft. and placed it in the water. Wood shavings and sawdust were scattered on the surface of the water under the chamber as it was lowered to seal the joints of the timber bulkhead in the bottom of the well.

While suspended partially submerged in the water, the walls of the circular well were raised by the addition of another concrete lift of a total height of 18¼ ft., which would equal the level of mean low water when the structure was sunk in final position. Above the concrete, the contractor erected an exterior timber-wall bulkhead 6 ft, high with battened joints and necessary internal bracing to provide additional draft required in floating the chamber and to keep the interior dry during high tides after the structure was placed on its foundation piles. In this condition, weighing 425 tons, the chamber was towed about 12 mi. by a tug to its final location, where the "Monarch" again picked up a part of the load and in a period of slack water lowered the structure on to timber piles cut off 23 ft. below mean high water level. A steam vacuum pump and a 4-in. gasoline-powered pump were installed in the chamber to eject leakage.

Outlet Chamber—At the base of the outlet chamber, the contractor will cast by tremie a concrete slab at least 32 ft. in diameter with a level surface at El.-21 (21ft. below mean high water) and with a thickness which tapers from 6 ft. at the center to 5 ft. at the outer edge. Rising from the concrete base are the 4-ft.-thick walls of the circular well, which has an inside diameter of 20 ft. Up to mean low water level, at El.-4.75 (the height to which concrete was placed before the outlet chamber was towed to position and sunk), the walls consist of plain concrete. Above this level, the walls are faced with granite and are topped out with a granite coping at El. 11.25. A solid concrete floor, located within the structure at El.1.75, supports hand windlasses for operating the sluice gates. The outlet chamber is covered at the level of the coping by a 15-in. concrete-slab roof paved with vitrified brick. This roof supports a steel-angle tower on which will be placed a white flashing marine beacon light.

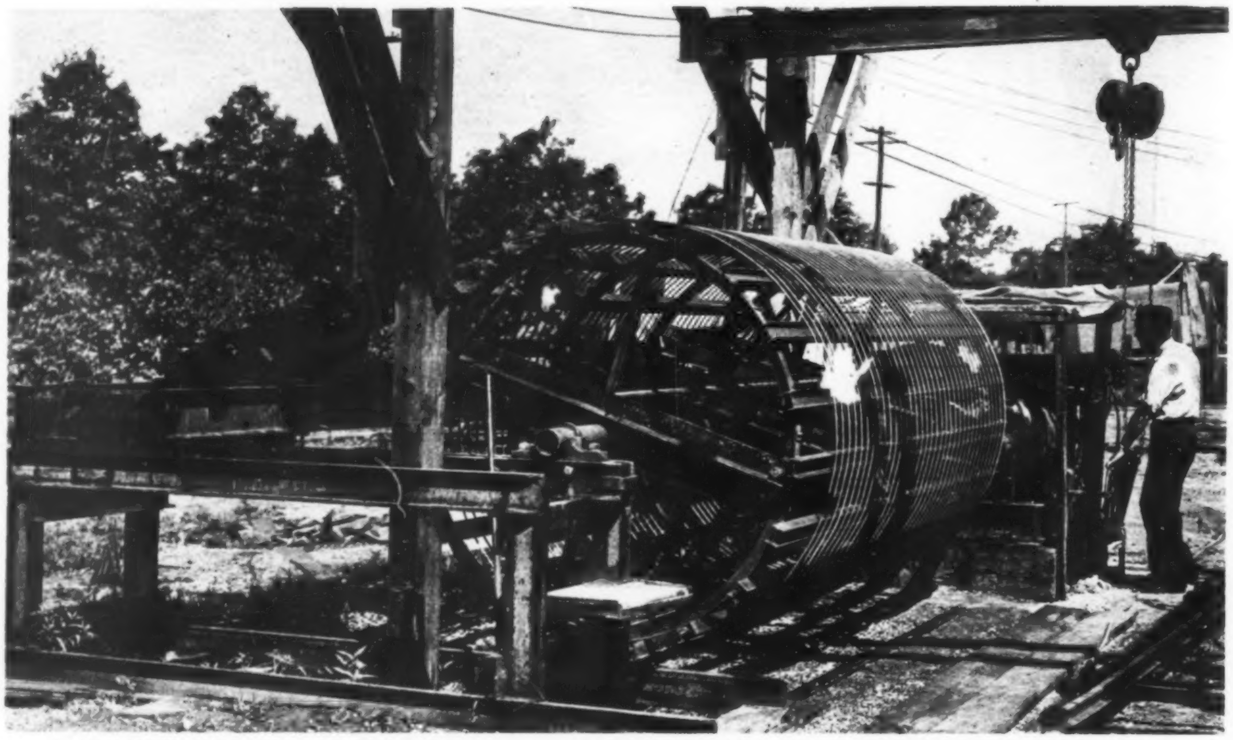
Prior to the driving of piles, the site of the outlet chamber was excavated in relatively shallow water between two dredged navigation channels, one leading to Sheepshead Bay and the other to Jamaica Bay. The 72-in. outfall sewer enters the outlet chamber from the north. On the south side of the chamber are three 42-in. cast-iron outlet pipes which extend for an average distance of about 44 ft. from the center of the structure, where each of them is designed to divide at a Y connection into two 30-in. cast-iron pipes. Only one of the three outlets is being completed under the present contract to take care of initial discharge from the sewage plant. The inverts of the inlet and outlet pipes in the chamber are at El.-20, 1 ft. above the surface of the concrete base.

Riprap protection is to be placed over the inlet and outlet pipes within the 44-ft. radius. Each of the two 30-in. outlets included in the present contract reduces in a distance of less than 180 ft. to a 10-in. cast-iron pipe, with short T-head risers (numbering nine in all for each pipe) installed at the reduction points and at the terminus. These risers act as diffusers, discharging the effluent into the waters of the inlet, where the sterile fluid is rapidly dissipated by the inrush and outrush of the tide. The trenches containing the outlet pipes are filled with crushed stone up to the bottom of the T-heads.

Lowering Chamber—As a means of suspending the outlet chamber from the falls of the floating derrick, the contractor cast three pairs of vertical steel

channels in the concrete walls of the structure at equal distances around the circumference, with the flat surfaces of each pair of channels facing each other and spaced about 6 in. apart. Steel plates were riveted to the outside faces of the webs of the channels to give additional bearing for steel pins inserted through reamed holes in the reinforced heads of each pair. Two wire-rope loops were passed under each of the three pins and were fastened by spliced thimble connections to double shackles on multi-sheave blocks of independent sets of hoisting falls, as illustrated by a photograph.

Three sets of hoisting falls, reeved through permanent blocks at the head of the giant boom to independent hoisting drums, lowered the outlet chamber to its final position on the timber piles, readily controlling the level of the structure at each stage of the operation. The main hoisting falls consisted of eleven parts of line, and each of the auxiliary falls was made up of six parts.



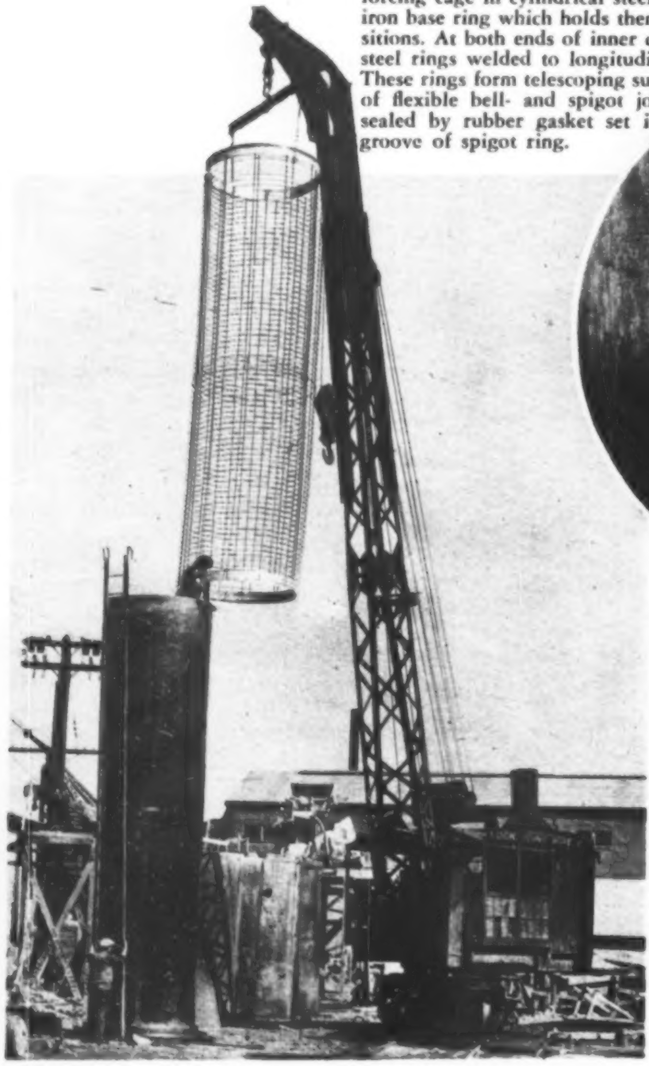
REINFORCING CAGE for 72-in. concrete pipe consists of No. 3 hot-rolled rod spirally wound at $3\frac{1}{2}$-in. pitch on rotating mandrel at manufacturer's plant. Wall of pipe, 7 in. thick, contains two cages. Prior to removal from mandrel, spiral is tied to $\frac{1}{2}$-in. round longitudinal rods, ten for inner cage and twelve for outer. Spirals are welded to longitudinal rods at ends and at several intermediate points.

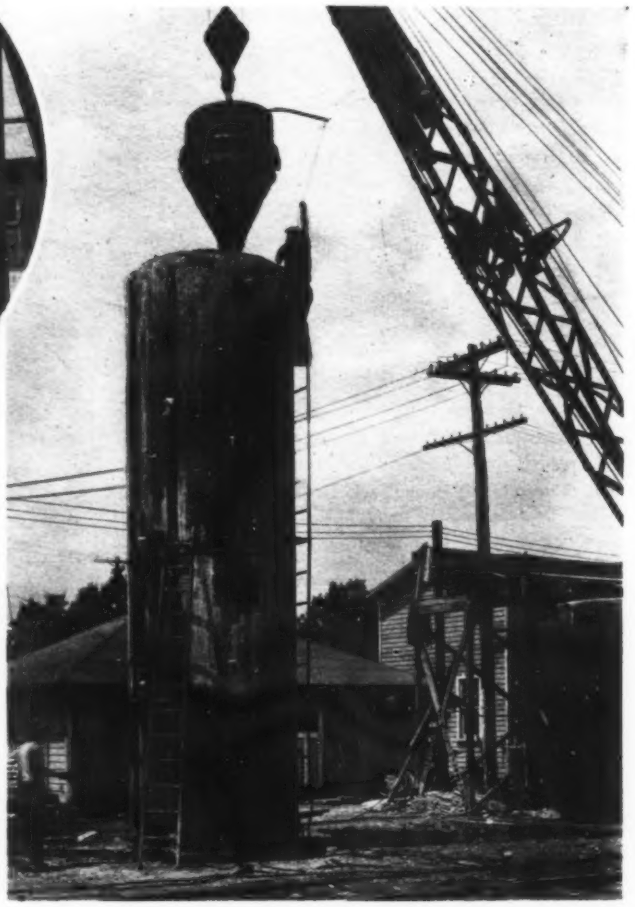
Three temporary pile platforms had been driven in the area to mark the location of the outlet chamber and had been equipped with tide gages. One of the pile platforms was about 25 ft. east of the final location of the outlet chamber. Before picking up the outlet chamber, the derrick boat "Monarch" was tied securely in an east-and-west position, parallel with the main tidal currents, by means of steel hawsers to submarine anchors. The outlet chamber, drawing about 20 ft. of water, was towed in on a rising tide to the north side of the "Monarch" and located close to final position. After the hoisting falls had been connected, the derrick picked up a load of about 175 tons, raising the top of the concrete portion of the structure about 5 ft. out of the water.

With the advent of slack water (high tide) at 1 p.m., daylight saving time, on Wednesday, August 21, 1935, the derrick began lowering the outlet chamber by gradually easing off the three independent sets of hoisting falls until the structure rested on the timber foundation piles at 2 p.m., 1 hr. after lowering began. A 4-in. pump and hose had been provided to fill the central well of the chamber, but the use of this equipment soon was discontinued because a large volume of water poured in through the battened joints of the 6-ft. timber wall. Two divers made several trips to the bottom to report on the final setting of the outlet chamber.

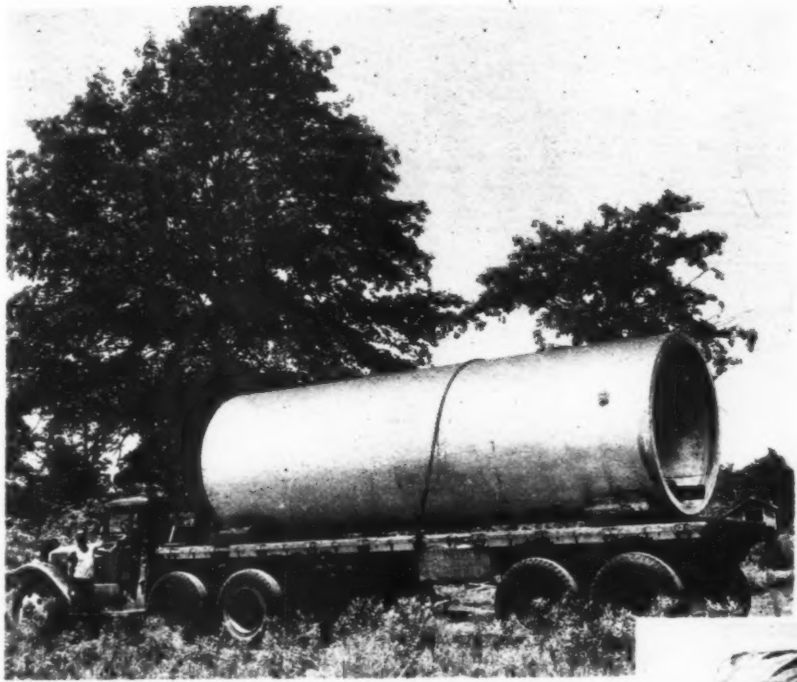
A single vertical line from the boom of a nearby derrick had been tied to an underwater pile bent to mark the exact center line of the 72-in. outfall sewer which had been laid to within 200 ft.

GOOSENECK CRANE *(left)* places inner reinforcing cage in cylindrical steel forms set on cast-iron base ring which holds them in concentric positions. At both ends of inner cage are galvanized steel rings welded to longitudinal rods. These rings form telescoping surfaces of flexible bell- and spigot joint, sealed by rubber gasket set in groove of spigot ring.

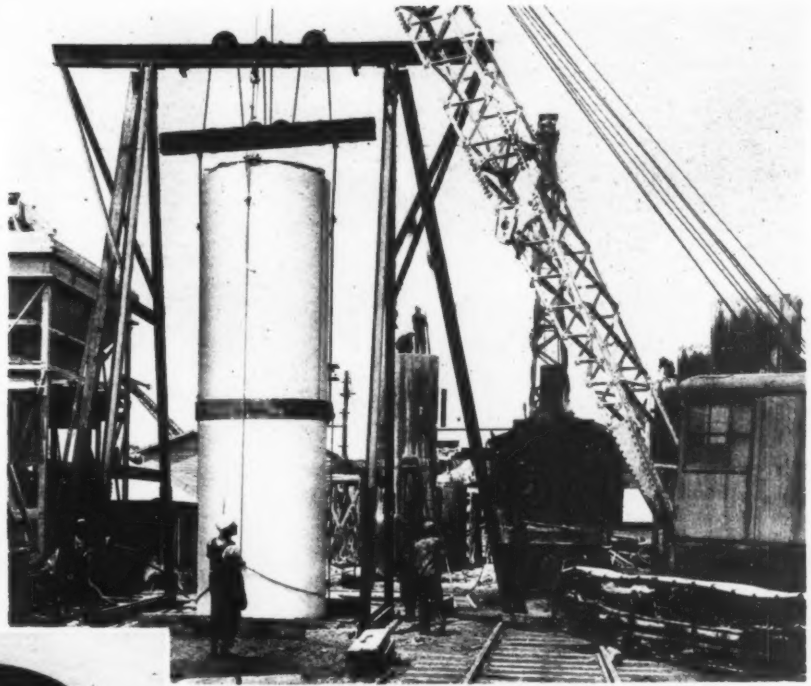




CONTROLLABLE-DUMP BUCKET *(right)* handled by locomotive crane deposits concrete on steel plate which covers top of inner form and serves to hold forms and joint ring in concentric positions. Two electric vibrators mounted in brackets on outside form *(see inset, above)* consolidate concrete during filling of forms. Lower vibrator is used until concrete is placed to its level, when it is shut off and upper one turned on until forms are filled. Some hand tamping is done at top of pipe.



LOADED ON TRUCK-TRAILER, 24-ft. pipe travels 10 mi. to wharf for transfer to lighter.



DOUBLE A-FRAME GANTRY and crawler crane turn pipe from vertical to horizontal position.

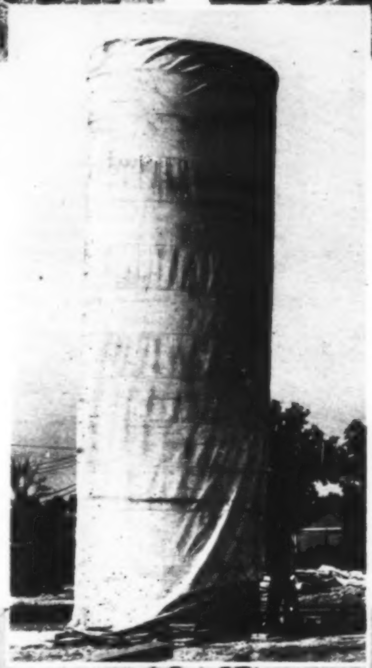
of the outlet chamber. Two vertical standards were erected on the outlet chamber at opposite ends of the north-and-south diameter to be brought into alignment with this line. At the initial setting, these standards were a few inches off exact position, and a subsequent pick-up and slight rotation were required to align the inlet of the chamber with the pipe.

Outfall Sewers — Under its contract the Merritt-Chapman & Scott Corp. is laying about $1\frac{1}{2}$ mi. of 6-ft.-diameter outfall sewer from the Coney Island sewage treatment works to the outlet chamber. About 1,600 lin.ft. of the sewer is being constructed on land, and the remaining 6,600 ft. is being laid in an excavated trench on the bottom of the bay. Pipe for the submarine portion of the line was cast in 24-ft. lengths weighing about 24 tons each at Kenilworth, N. J., by the Lock Joint Pipe Co. For the land portion of the sewer, the pipe sections were made 12 ft. long for ready handling by crawler-mounted equipment.

Except for less than 2,000 ft. of the submarine portion of the sewer crossing the Sheepshead Bay channel, the entire line both on land and under water is laid in a foundation of good clean sand. Crossing the channel, the pipe drops for a distance of 1,425 ft. to invert El.-44. Because a heavy deposit of silt had settled in the bottom of the channel, it was necessary to support this portion of the sewer on pile bents. Timber piles were driven to required penetration with an underwater hammer and were cut off and capped by drivers who used air tools for cutting off the tops of the piles and driving 2-ft. spikes through drilled holes in the caps into the pile bents. As the divers had to perform all this work in murky, silt-laden water, they carried out the various operations with complete success almost entirely by the sense of touch.

Submarine Pipe — Pipe joints are sealed by a rubber gasket and are coupled by two $1\frac{1}{2}$-in. bolts drawn up

LIVE STEAM *(right)* inside canvas jacket cures con crete pipe for 2 days.



ON LAND SECTION *(below)* crawler crane handles 12-ft. pipe lengths weighing 11 tons each.

through steel lugs welded to anchor bars embedded in the concrete on opposite sides of the pipe. In constructing the submarine portion of the sewer, the contractor lowers two coupled pipe sections, aggregating 48 ft. in length, suspended in horizontal position from a structural steel strongback, as shown by one of the photographs. The complete assembly weighs about 55 tons.

In the end of the pipe which is to be connected to the portion of the line already laid, the construction crew installs a collapsible steel pilot point. A rope attached to a trigger release on this semi-ellipsoidal steel frame leads back to the open end of the 48-ft. pipe unit.

The pilot point aids a diver on the bottom of the bay in guiding the pipe unit into the portion already laid. After drawing up the bolts between the steel lugs at the joint, the diver pulls the rope to release the pilot point, and the collapsed frame is drawn to the surface to be used in the next pipe unit.

Personnel—Thomas W. Hammond is commissioner of the Department of Sanitation and Walter D. Binger is deputy commissioner in charge of the Division of Engineering. The Coney Island sewage treatment works and the outfall sewer were designed and are being constructed under the direction of R. H. Gould, chief engineer, and William L. Sylvester, designing engineer. A. R. Glock, resident engineer, is in direct charge of the work.

A loan and grant from the Federal Emergency Administration of Public Works provided the funds for the project. Arthur S. Tuttle is state engineer for the PWA, and Colonel M. E. Gilmore is state engineer-inspector.

For the Merritt-Chapman & Scott Corp., of New York, general contractor for the outfall sewer, construction is being carried out under the general direction of George Burrows, vice-president, with C. B. Christiansen, construction superintendent, in charge at the site.

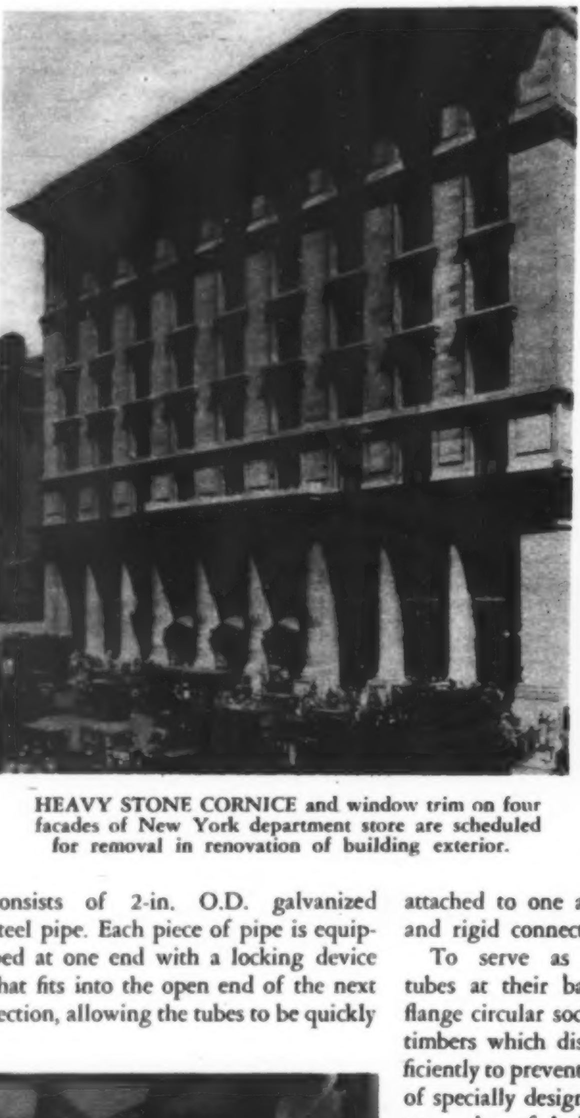
World's Largest Installation of

TUBULAR STEEL SCAFFOLDING

Speeds Modernization of Department Store Exterior

By RUDOLPH P. MILLER

Consulting Engineer,
New York City

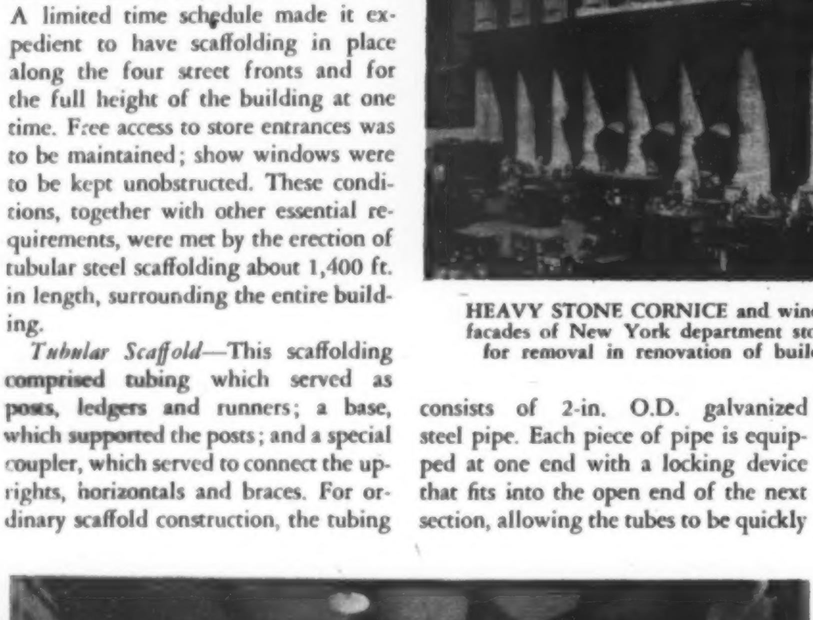


HEAVY STONE CORNICE and window trim on four facades of New York department store are scheduled for removal in renovation of building exterior.

MODERNIZED EXTERIOR of store building dispenses with heavy stone ornamentation to gain appearance of simplicity and increased height.

A RECENT building alteration, involving a number of exacting requirements, required the most extensive scaffolding, certainly of its own type, ever erected. B. Altman & Co., located at Fifth Ave. and 34th St., one of the busiest street intersections in New York City, found it desirable to overhaul the exterior walls of their eight-story department store occupying the entire block between Fifth and Madison Aves., 34th and 35th Sts. A limited time schedule made it expedient to have scaffolding in place along the four street fronts and for the full height of the building at one time. Free access to store entrances was to be maintained; show windows were to be kept unobstructed. These conditions, together with other essential requirements, were met by the erection of tubular steel scaffolding about 1,400 ft. in length, surrounding the entire building.

Tubular Scaffold—This scaffolding comprised tubing which served as posts, ledgers and runners; a base, which supported the posts; and a special coupler, which served to connect the uprights, horizontals and braces. For ordinary scaffold construction, the tubing consists of 2-in. O.D. galvanized steel pipe. Each piece of pipe is equipped at one end with a locking device that fits into the open end of the next section, allowing the tubes to be quickly attached to one another by a positive and rigid connection.

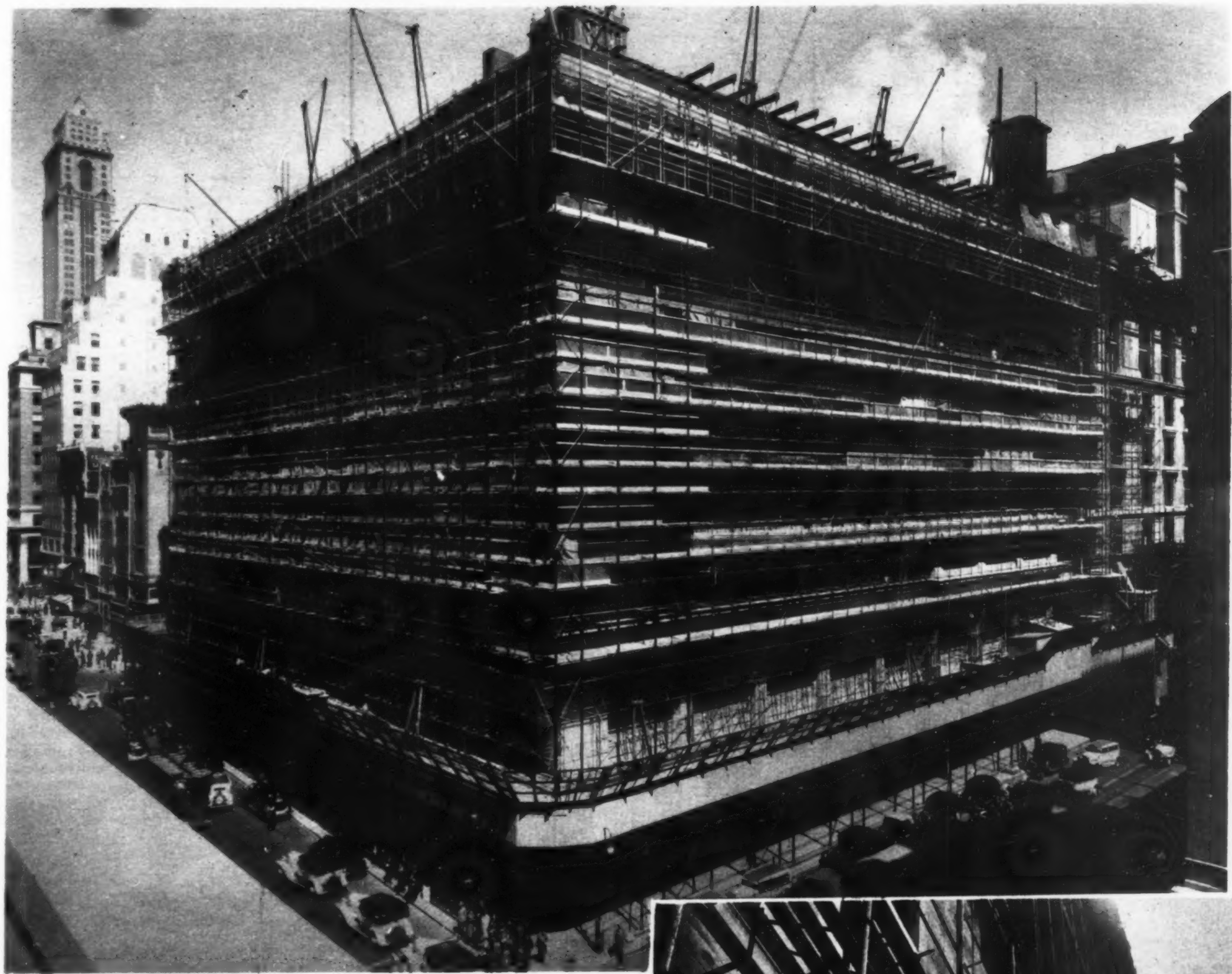


4½-IN. PIPE POSTS resting on timber sills at curb and building lines support rolled structural shapes spanning sidewalk, store entrances and show windows.

To serve as posts, the vertical tubes at their base are set in wide-flange circular sockets resting on heavy timbers which distribute the load sufficiently to prevent settlement. By means of specially designed couplers, the runners, also of locked tubing, and the bearers, generally of single lengths of tubing, are securely attached to the posts at such levels as best suit the purposes of the scaffolding. An adjustable coupler, that permits of other than right-angle connections, is used for the bracing, a highly essential element of the structure. The result is a strong, rigid, light framework to support the planks that form the working platforms.

Scaffold Design—In the Altman scaffolding three conditions necessitated the use of 4½-in. tubing for posts at the street level. Somewhat heavier scaffold loads than usual had to be provided for; store entrances and show windows had to be kept free and unobstructed and sidewalks had to be kept clear for pedestrian traffic on all four streets. For spans of 15 to 30 ft. required in the lower part of the scaffolding, structural steel shapes were introduced and framed to posts set at the street curb and at the sides of store entrances and show windows along the building line. This construction also served as the sidewalk shed, required by a city ordinance, for the protection of pedestrians.

In removing a heavy cornice that girdled the building at the ninth floor level and in cutting away all window trim and other stone ornamentation, blocks weighing 500 to 8,000 lb. had to be handled, requiring a capacity of 200 lb. per square foot on the platforms. The scaffold was designed to provide ample working space and protection against falls. Scaffold accidents constitute one of the major hazards of the building industry. At times, under the direction of the general contractor, Marc Eidlitz & Son, of New York City, upward of 300 men, including stone cutters, bricklayers, carpenters, laborers and others, were engaged without accident in their various trades on the



TUBULAR SCAFFOLDING nine stories high and 1,400 ft. long, surrounding four sides of large department store building, requires 67 mi. of galvanized steel pipe. Platforms are laid with 10,000 planks chemically treated for fire resistance.

structure. As a safeguard against missteps and to prevent the accidental dropping of loose materials or small tools, wire mesh was used at the several platform levels to fill in the space between toe boards and railings.

Fire Hazard—In recent years serious property damage has resulted from several scaffold fires. During the construction of the State Education Building at Harrisburg, Pa., in 1930, the contractor suffered a loss of more than $50,000 by the burning of his scaffolding. More recently, in 1933, fire destroyed the scaffolding around the Interstate Commerce Building at Washington, D. C., causing damage estimated at $40,000. A more familiar instance, because more spectacular, and also more destructive, the damage being estimated at $200,000, was the fire in the scaffolding surrounding the tower of the Sherry-Netherlands Hotel, New York City. What made this fire particularly serious was its inaccessibility, more than 350 ft. above the street, and the added danger that falling embers might set fire to neighboring buildings.

A consideration of the fire hazard played no small part in the determination to use tubular scaffolding on the Altman job. A tubular steel framework, being incombustible, presents no risk in this respect. To eliminate the danger inherent in the use of wood for the platforms, as the only material suitable for that purpose, every scaffold plank was treated by impregnation with suitable chemical solutions to render it fireresistant. This chemical treatment of platform planks is now the regular practice of the Chesebro, Whitman Co., Inc., the lessor of the scaffolding

Material Quantities—Construction of the scaffold required about 67 mi. of pipe, 78,000 couplers, 800 tons of structural steel, 60,000 sq. ft. of wire mesh, and 10,000 fire-safe selected planks, aggregating 2,400 tons in all. Erection and dismantling were accomplished with ease and despatch. Before returning the several parts to the storeroom, each piece was examined and thoroughly cleaned and reconditioned for future use. The scaffolding met the prime requisites of strength, stability, commodiousness, and fire-resistance, while its flexibility made it adaptable to the unusual conditions encountered. Its open framing, which reduced obstruction to light, and noiseless erection found favor with the store management.

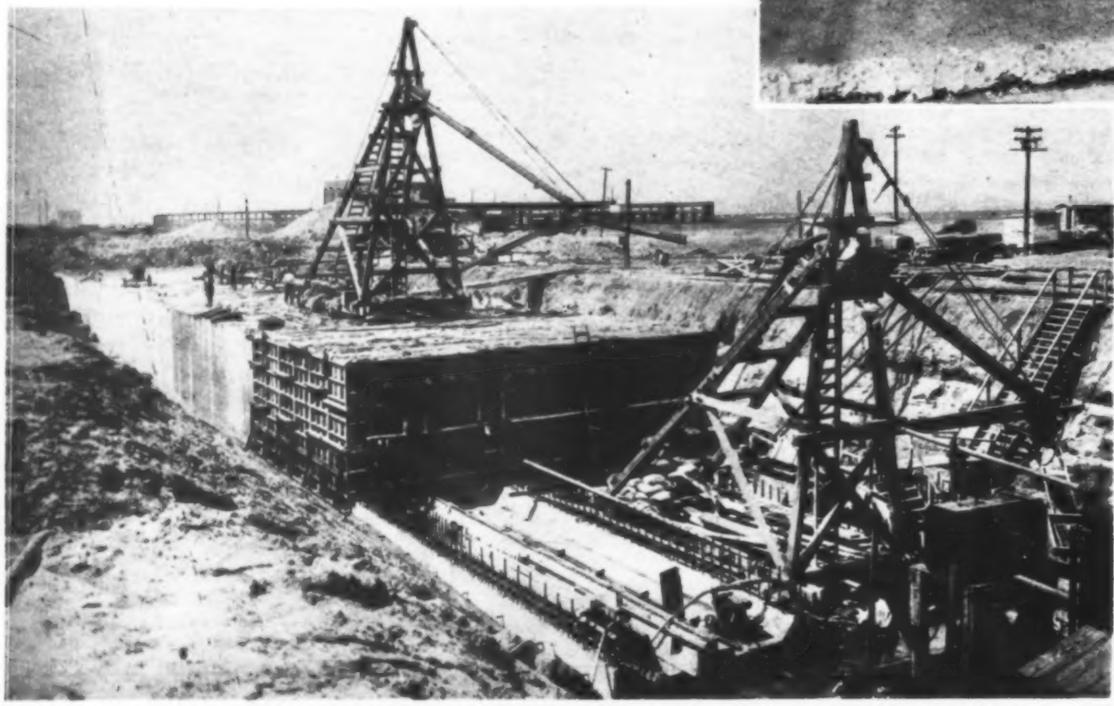
POSTS, RUNNERS, LEDGERS AND BRACES are connected by special couplers which facilitate erection and dismantling. Toe boards, guard rails and wire mesh along outer edges of platforms prevent falls and dropping of tools and materials.

Getting Down to

DETAILS

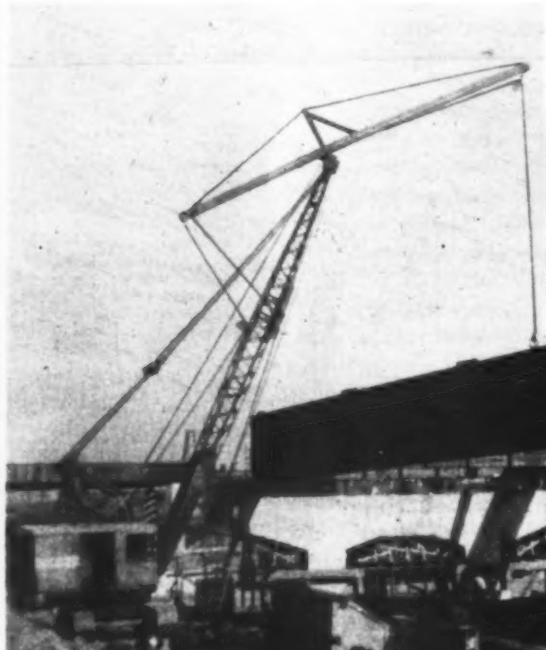
Close-up Shots of Job Methods and Equipment

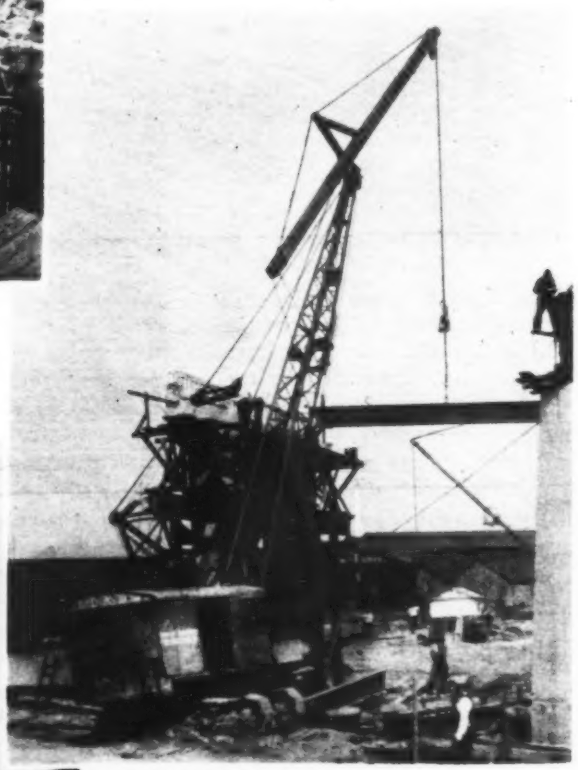
"PNEUMATIC JACKING" is novel method applied by New Jersey Highway Department to form central 12-ft. wide traffic-separating strip for accident prevention on 8-mi. section of main route (No. 26, West of New Brunswick) between New York and New Jersey. Scheme involves sliding strip of four lane concrete pavement laterally by first inserting deflated rubber tube along center-line joint and filling with compressed air. Successive "shoves" are made with aid of wood blocking, as illustrated, to form abutment against which tube may react during inflation to push concrete slab sideways.



TRAVELING DERRICKS DISTRIBUTE CONCRETE for triple 12x12-ft. box section of Cahokia Creek diversion conduit in East St. Louis, Ill. On 1,900-ft. section of $1,993,731 contract for East Side Levee & Sanitary District (E. F. Harper, Chief Engineer),G. L. Tarlton, contractor, of St. Louis, Mo., adopts plant setup consisting of central mixing plant with 2-yd. mixer supplying trucks which deliver to hopper above concrete pump. Concrete is then pumped through 7-in. pipe line to receiving hoppers on two movable derricks, whence it passes down inclined chutes to forms for invert, sidewalls and roof.

TO FOIL MARINE BORERS cedar-pile logging train trestle of Weyerhaeuser Timber Co. across shallow arm of Puget Sound near Tacoma, Wash., receives ½-in. protective coating of Gunite, (1:4 cement-sand mix with 5 per cent of calcium chloride) applied at low tide. Tidal range, 17 ft.

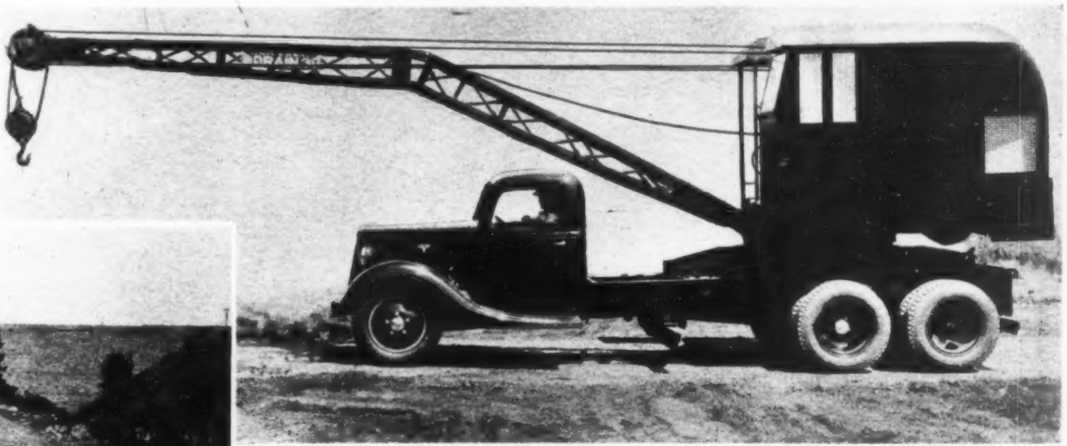




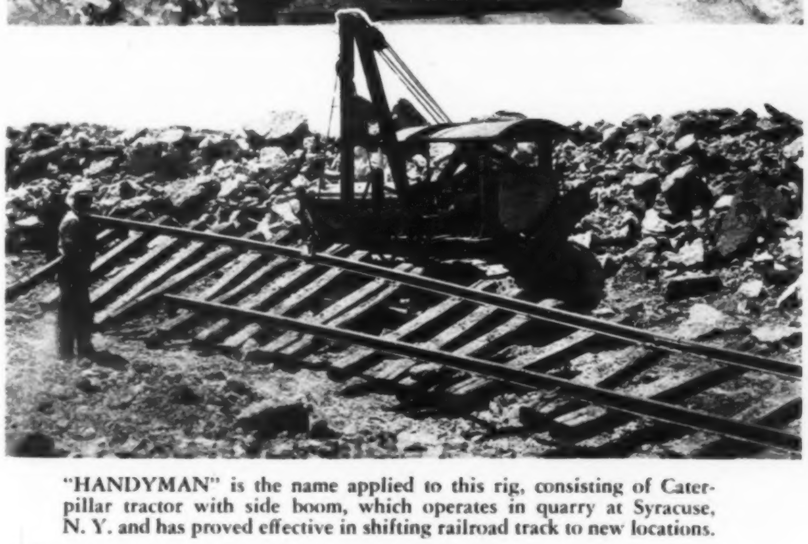
PIVOTED BOOM EXTENSION *(above and at right)* on Northwest crawler crane of Joe Gerrick & Co., of San Francisco, aids rapid erection of steel floor beams and stringers of traffic distribution structures serving San Francisco-Oakland Bay bridge in California. Length of main boom is 50 ft. The 50-ft. extension, of 12x12-in. timber, strengthened by hog-rods, reaches 30 ft. beyond boom end. Extension, connected to boom by steel pin, is easily removable, works through angle of 90 deg., and is controlled by cable from crane drum. Maximum weight of steel members handled, 5 tons. Extension eliminates need for excessively long main boom by reaching over main girders to place floor system. —*Photos from* IRVING GOTTHEIM, *Joe Gerrick & Co., San Francisco.*

FOR CARRYING STEEL REINFORCEMENT RINGS *(above and right)* used in construction of concrete siphons on Colorado River aqueduct in California, the Griffith Co., contractor of Los Angeles, has designed and built the special trailer illustrated herewith. On the trailer chassis is a welded tubular steel frame against which the rings of steel reinforcement, 12 ft. in diameter, are stacked. Chains at the top of the frame prevent the rings from being displaced during transit. The trailer has a carrying capacity of thirty 12-ft. rings.

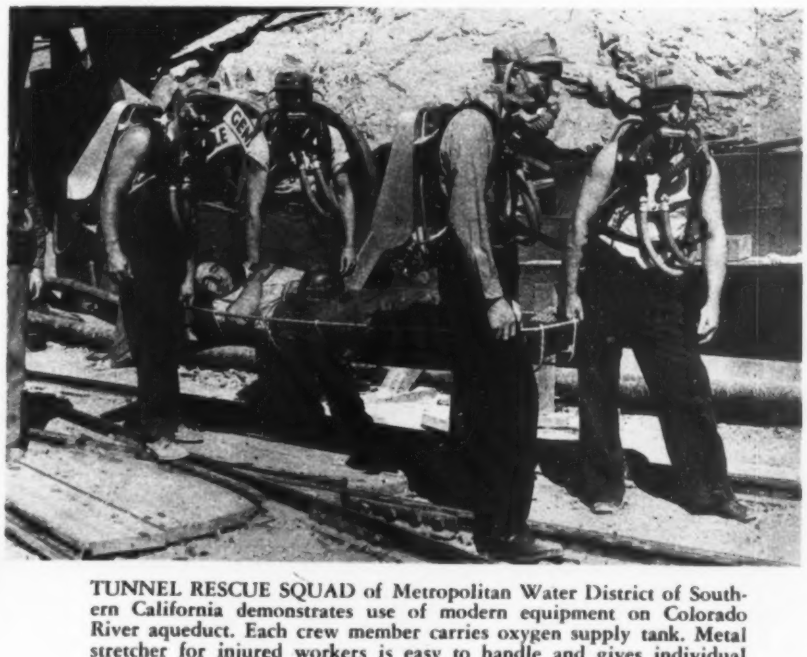
STEEL-LINED SPILLWAY. *(Below)* In addition to a steel plate facing on the upstream side of the 170-ft.-high gravel fill forming El Vado dam in New Mexico the spillway of the structure, excavated in rock and lined with concrete, is protected by welded steel plates ⅝-in. thick on bottom and ¼-in. thick on sides. Spillway entrance is 32 ft. wide and 19 ft. deep.



LOW CLEARANCE while traveling from one job to another is a feature of this new Lorain full-revolving crane on a standard Ford V-8 truck equipped with auxiliary or third axle. Boom 25 ft. long is fitted with a hinge connection at the center so that top section can be lowered and held in place during transit, by a couple of links. Links are removable to allow boom to be straightened out before rig is placed in service.

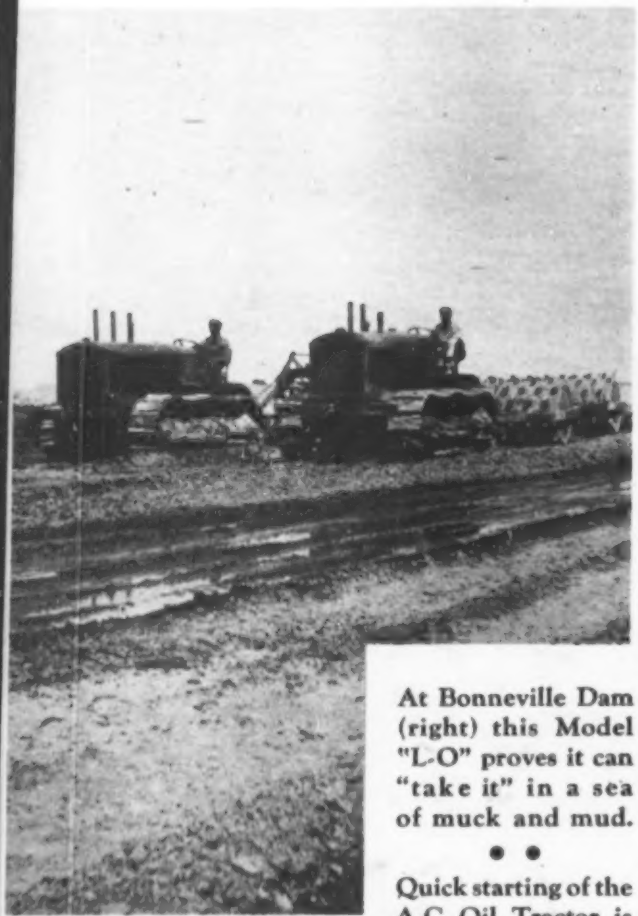


"HANDYMAN" is the name applied to this rig, consisting of Caterpillar tractor with side boom, which operates in quarry at Syracuse, N. Y. and has proved effective in shifting railroad track to new locations.



TUNNEL RESCUE SQUAD of Metropolitan Water District of Southern California demonstrates use of modern equipment on Colorado River aqueduct. Each crew member carries oxygen supply tank. Metal stretcher for injured workers is easy to handle and gives individual support to each leg of patient.

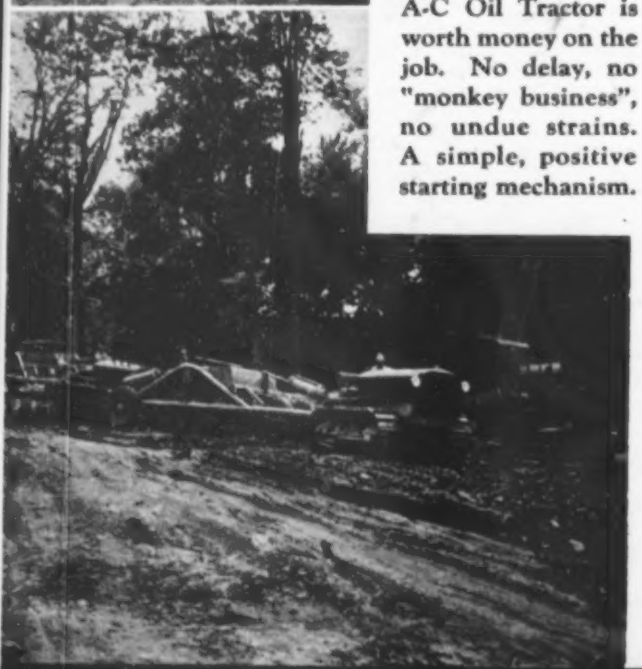
THE A-C HAS *What*



At Bonneville Dam (right) this Model "L-O" proves it can "take it" in a sea of muck and mud.

• •

Quick starting of the A-C Oil Tractor is worth money on the job. No delay, no "monkey business", no undue strains. A simple, positive starting mechanism.



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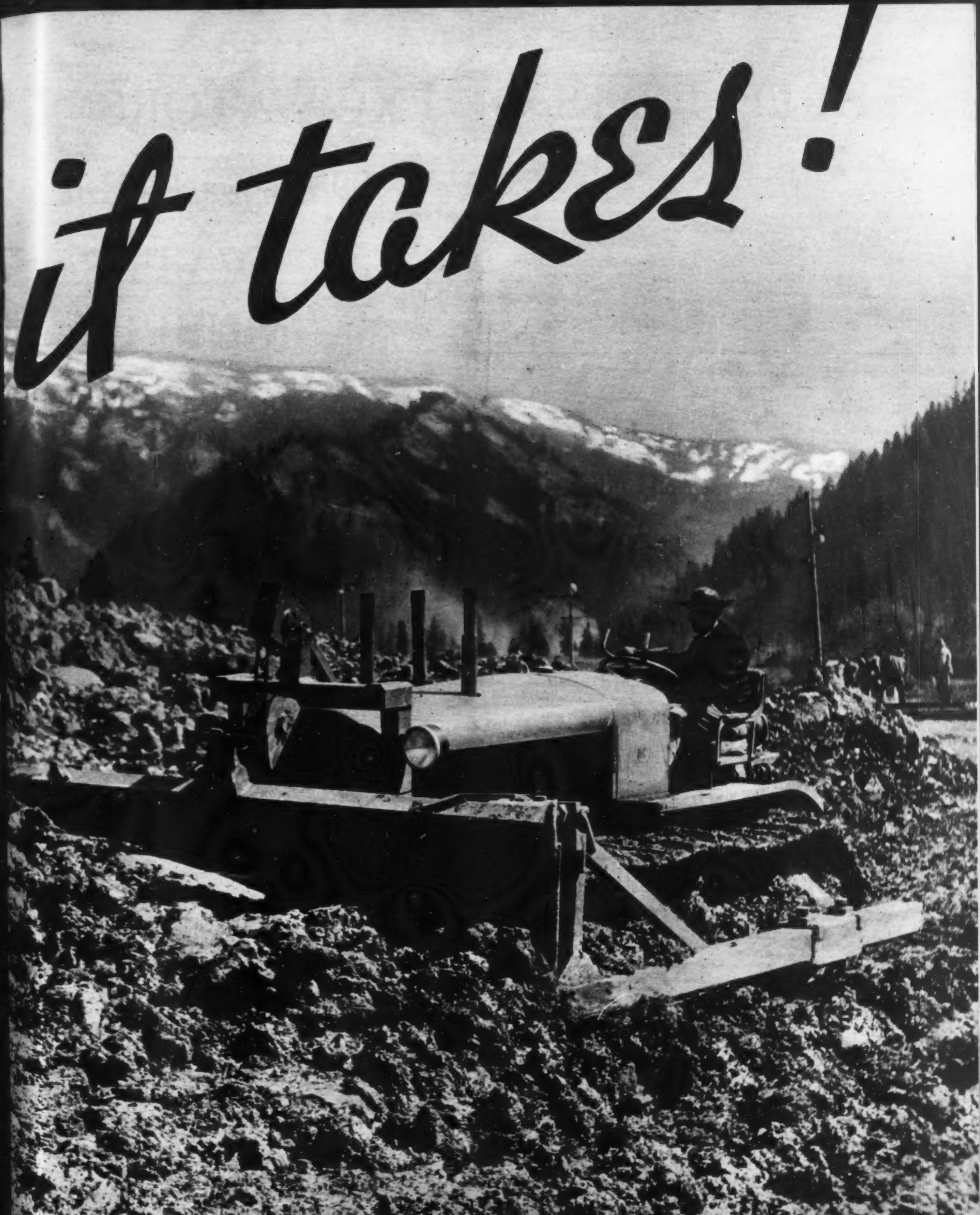

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THREE TYPES OF EXCAVATORS

Dig Trenches for 17-Mile

WATER SUPPLY LINE

FLOATING DERRICK, assembled at lake on rectangular steel pontoons, handles double lengths of 20-in. by 40-ft. spiral welded pipe for subaqueous portion of water main.

FIVE EXCAVATING and pipe-laying crews using three different types of trench-digging equipment were engaged in constructing a 17-mi. water-supply line of spiral-welded pipe 20 in. to 12 in. in diameter, connected throughout with flexible bolted couplings, from Lake Canandaigua to the village of Palmyra about 20 mi. east of Rochester, N. Y. Almost 1 mi. of 20-in. pipe is laid on the bottom of the lake, connecting an intake manifold with the land line. One of the crews constructed this portion of the line. Depending upon the depth of trench and the character of soil, which ranges from wet muck near the lake to a variety of good clay-gravel, hardpan, and quicksand farther north, the Cornell Contracting Co. Inc., of New York City, general contractor, operated a dragline, a back-hoe, and two trenching machines with its four land crews. Each of the trenching machines was followed by a pipe-laying crane and a backfiller. The dragline and back-hoe handled pipe and backfilling in addition to trench excavation.

Village Water Supply—Palmyra had been supplied with water by a storage reservoir east of the village which collects the runoff in a small drainage area. For the last few years, because of the drought, this source had not been sufficient, and the village had to obtain additional water from local wells and from the New York State barge canal, which passes through the corporation limits. At no time did the village have sufficient water to supply the manufacturing industries within its borders. Furthermore, water from the local source is very hard, having a hardness of 500 p.p.m. In seeking an additional supply, the village determined to furnish water not only to its residential and business sections but also to its manufacturing plants.

SUBMARINE JOINTS are reinforced with four 1½-in. bolts drawn up between welded lugs on walls of pipe.

1¼-YD. DRAGLINE excavates deep trench for pipe in wet muck near lake.

Palmyra lies half way between Lake Ontario and Canandaigua Lake, the only two sources for an adequate supply. As water from Lake Ontario would require pumping, while water from Canandaigua Lake could be obtained by gravity, the latter source was chosen. The water is much softer than the present supply, having a hardness of 114 p.p.m.

Water Supply Line—Laid on a down grade from the lake to the existing reservoir, the line is designed to deliver the water by gravity with a friction coefficient of 100 at the rate of 1,500,000 g.p.d. By the use of Wailes-Dove-Hermiston bitumastic enamel lining in the pipe, it is expected that the friction coefficient will be nearer 140 or 150, enabling the line to deliver at least 2,000,000 g.p.d. Various pipe sizes were selected for the line to avoid deep cutting, the larger sizes having less friction for the same volume of water than the smaller sizes. The pipe line will take care of the needs of the village for many years.

In obtaining bids for the pipe line, quotations were asked on cast-iron, wrought-iron and steel pipe. Welded steel pipe was much lower than either of the others. Careful study was made of the use of steel pipe throughout the country, and it was decided that for

the soil conditions in which this pipe was to be laid, steel pipe with bitumastic coating on the outside and enamel lining on the inside would last as well as any pipe on which quotations were obtained.

Mechanical couplings were selected in preference to welded joints, and the Dresser Manufacturing Co. was low bidder on the couplings. The line is carefully protected by gate valves, blow-off valves and combination air and vacuum valves.

A notable feature of the supply line is an automatic arrangement by which part of the water will be sent through the filtration plant and thence into the village reservoir and distribution system, while another part will go directly to the manufacturing plants unfiltered, although chlorinated, to be used for manufacturing purposes only. About 1 mi. of 12-in. pipe was laid under the Cornell contract across the barge canal into the plant of the Garlock Packing Co., the largest local industry. The entire project called for about 18,700 ft. of 20-in. pipe, 5,200 ft. of 18-in., 6,200 ft. of 16-in., 20,200 ft. of 14-in., and 40,600 ft. of 12-in.

Except for about 5,000 ft. of 20-in. pipe in the lake and 5,900 ft. of 12-in. between the reservoir and the industrial plant (both of which have spiral-welded pipe of 1/4-in. wall thickness), the line is made up of pipe with a wall thickness of 7/32 in., supplied in 40-ft. lengths by the American Rolling Mills Co. The pipe was coated with bitumastic enamel to protect it from corrosion and attack by soil acids and was given a top coat of white paint in the shop to reduce the effect of expansion under a hot sun and facilitate detection of any breaks in the enamel covering suffered in transit.

Pipe connections throughout the entire line are made with Dresser couplings sealed with Garlock rubber gaskets. Minimum depth of cover over the pipe is 3½ ft., and the maximum depth of trench is 16 ft. for a distance of about 1,000 ft. William S. Lozier, Inc., of Rochester, consulting engineer, designed the water-supply line and was in charge of construction.

Digging Equipment— Wherever practicable the contractor excavated with the two ladder-type trenching machines, which made rapid progress when cutting trenches in stable soil that was not too hard. In wet, unstable soils which would have required sheeting if excavated by the trenching machines, the contractor preferred to make a wider cut with the dragline or back-hoe, eliminating the expense and delay of sheeting. For the deep, wet excavation near the lake, a P&H dragline with a 1¼-yd. bucket dug a trench with sloping banks, and the bottom of the cut was kept dry with a pump. In the deeper cuts in hardpan or wet soil on other parts of the line, a Northwest back-hoe equipped with a narrow ¼-yd. bucket excavated to the required side slopes. Both of these machines placed a pipe length and backfilled the trench as soon as they had completed excavation for a sufficient distance. They never had more than 40 ft. of open trench behind them.

Two sizes of Austin trenchers were used to cut trenches from 24 in. to 42 in. wide. A 30-in. unit operated without side-cutters to dig a 24-in. trench for the 12-in. pipe. When digging in good soil to a 4½-ft. depth, this machine excavated 1,200 ft. of trench in a working day of 10 to 12 hr. Pipe was laid close behind the trencher by an Austin backfiller which functioned as a side-boom crane for this work.

M. J. COFFEY *(left, below)* general manager, and STEPHEN COFFEY, engineer, Cornell Contracting Co., Inc.

IN HARDPAN AND QUICKSAND, ¼-yd. back-hoe makes cuts which are beyond capacity of trenching machines.

BEHIND PIPE-LAYING CRANE, backfiller covers pipe with excavated material deposited by trenching machine.

OPERATING AS CRANE, another backfiller lays pipe in trench excavated by ladder-type digging machine. Spiral-welded pipe, protected by bitumastic coating on outside and enamel lining on inside, is given top dressing of white paint in shop to reduce effects of hot sun and reveal surface abrasions suffered in handling.

INTAKE MANIFOLD of 20-in. pipe and 20-to-30-in. enlargers, with bolted flanged couplings, is assembled at lakeside on 70x30-ft. timber raft.

Several lengths behind the pipe-laying unit, a second Austin backfiller drew excavated spoil back into the trench.

For the larger pipe sizes, requiring deeper and wider cuts, the contractor used a 42-in. trencher with side-cutters. This machine frequently excavated 600 to 800 ft. of trench 5 or 6 ft. deep in a day. An Austin crane laid pipe behind this trencher, and a backfiller covered the pipe.

Pipe joints were coupled as soon as they were laid in the trench. Before

STARTING ITS DESCENT to bottom of lake in 60 ft. of water, lowering of intake is controlled by hoist line from floating derrick.

being installed on the pipe, the steel sleeve and two steel flange rings of each coupling were coated with an elastic bituminous joint compound heated to 200 deg. F., in portable kerosene-fired kettles which traveled along the line with the digging crews. Breaks and scratches in the enamel coat on the pipe were repaired with bitumastic enamel heated to 500 deg. F., in kettles which were used for this material exclusively.

Lake Section—To handle pipe at the wharf in the town of Canandaigua and to lay the line in the lake, the contractor assembled a floating A-frame derrick on riveted rectangular steel pontoons. The pontoons were 6 ft. deep and 8 ft. wide. Under the mast was a pontoon 43 ft. long, and behind it under the derrick sills were two parallel pontoons each 24 ft. long. After the tanks had been fabricated and shipped from Rochester, the contractor welded the seams at points where a visual inspection indicated that further sealing might be advisable. The three pontoons were placed with a 5-ft. spacing between parallel tanks on improvised ways near the wharf at Canandaigua and were connected to form a structural unit by means of welded 6-in. channel braces and 1¼-in. bolted tierods.

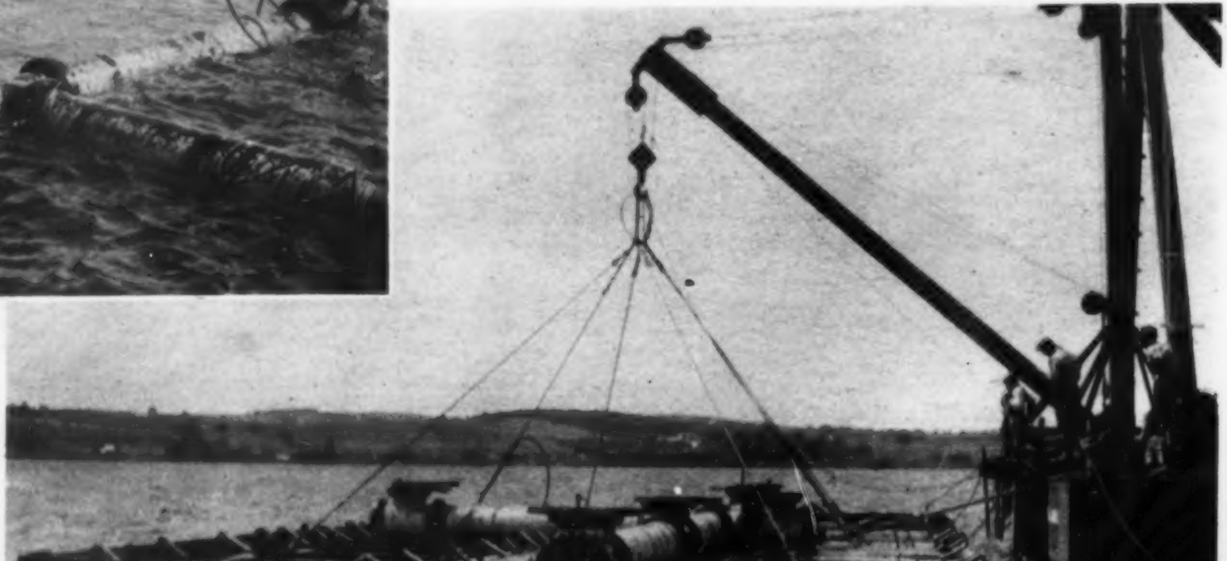
On the pontoons the rigging crew erected an 8-ton Dobie A-frame barge derrick with a 12x12-in. by 20-ft. mast and a 12x12-in. by 30-ft. boom. The derrick was driven by a Lidgerwood gasoline hoist equipped with three hoist drums and a swinging engine which turned the mast by a line around an 8-ft. bullwheel. An Ingersoll-Rand 310-cu.ft. compressor also was mounted on the pontoons.

After the floating derrick had been launched, carpenters constructed on the same ways a 70x30-ft. timber raft to support the intake manifold of 20-in. pipe and six 20-to-30-in. enlargers. The raft was launched and towed to final position about ½ mi. from the wharf, where it was sunk in 60 ft. of water by loading with stone riprap and opening the inlet valves of the manifold. The L. A. Wells Construction Co., of Cleveland, held a subcontract for all the submarine work, including the laying of 5,000 ft. of 20-in. pipe on the bed of the lake and the final connection to the manifold which was made by diver. As indicated by a photograph, the pipe in the lake portion of the line was equipped with special submarine couplings which provided four 1¼-in. tie-rods between welded lugs on the ends of adjoining pipe lengths, in addition to the regular Dresser couplings at the joints. Alternate couplings were made at the wharf, and the pipe was transported to the site on barges and connected into the line in 80-ft. lengths.

Railroad Crossings — Three underground railroad crossings in the line were prepared in advance by jacking 36-in. Armco corrugated pipe under the tracks. The longest crossing is 80 ft. in length. A subcontract for the pipe jacking was executed by the Drainage Engineering Co. of Middletown, Ohio, a specialist in this field.

Progress — Trenching operations started May 28, as soon as the first pipe was delivered to the project. The line was completed in September.

Direction—Supervision of construction in the field rested with Sidney D. McKnight, engineer in charge for William S. Lozier, Inc. Operations were directed for the Cornell Contracting Co., Inc., by M. J. Coffey, project manager, and Joseph A. McCabe, superintendent.



READY TO BE WEIGHTED with stone for sinking, raft is suspended from derrick boom above final location of intake.

LADIES' AUXILIARY does its trick on new Mossoviet Hotel, Moscow. Soviet building trades make no odious distinctions between male and female labor. "Let the girls carry the hods," say they.

Wide World Photo

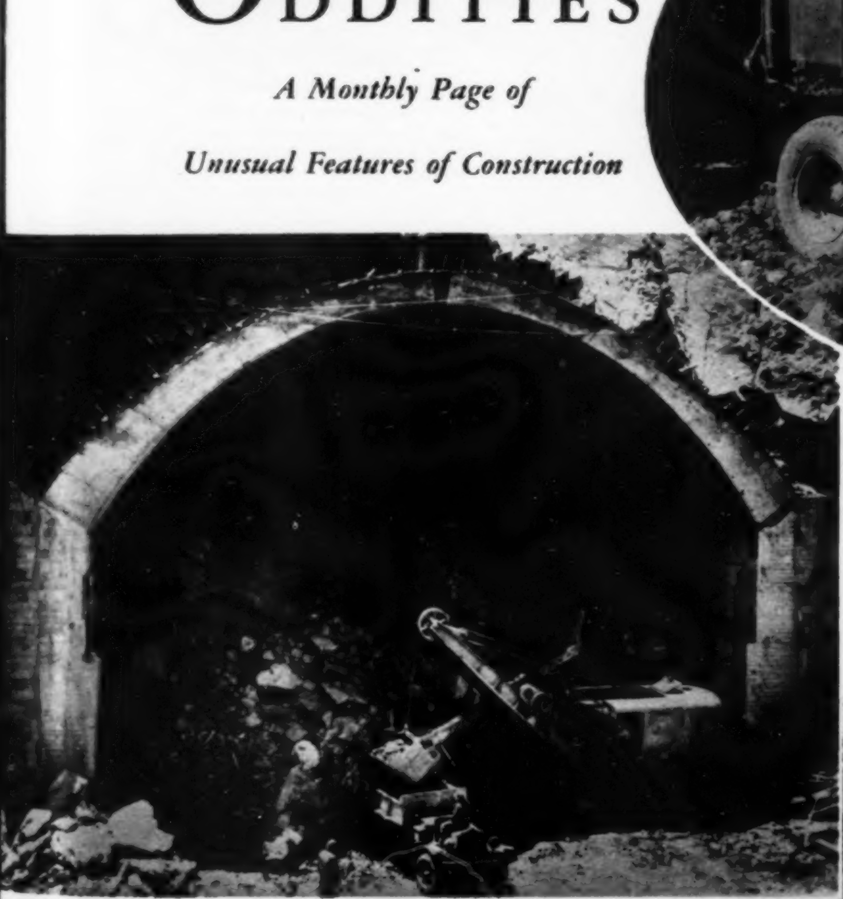
LOOKING FOR TROUBLE. Member of mine rescue team at camp of Metropolitan Water District of Southern California is equipped for action in event of emergency in Colorado River aqueduct tunnel. Tank and control valves on man's back supply oxygen through hose to his mouth, while nose pincers clamp his nostrils shut.

JOB ODDITIES

A Monthly Page of

Unusual Features of Construction

WEATHER FAIR, TRACK FAST. "Head Play," White truck entry, goes to post at Grand Coulee dam in daily race for earth-moving honors among units of haulage fleet named for thoroughbreds of Mrs. Silas B. Mason's racing stable. Mason-Walsh-Atkinson-Kier Co. is contractor on project.



CONSTRUCTION PROCEDURE REVERSED in building Yerba Buena Island tunnel connecting two bridges of San Francisco-Oakland Bay crossing. Reinforced-concrete tunnel lining is constructed in advance of core excavation by driving pilot tunnels at sides and crown and enlarging these tunnels to complete side walls and arch. Tunnel is 58 ft. wide and 76-ft. high to accommodate double-deck roadway.

ANCIENT SUSPENSION BRIDGE *(below)* supported by multiple eyebar chains strung between stone towers at Conway Castle, in North Wales, is scheduled for replacement by modern structure.

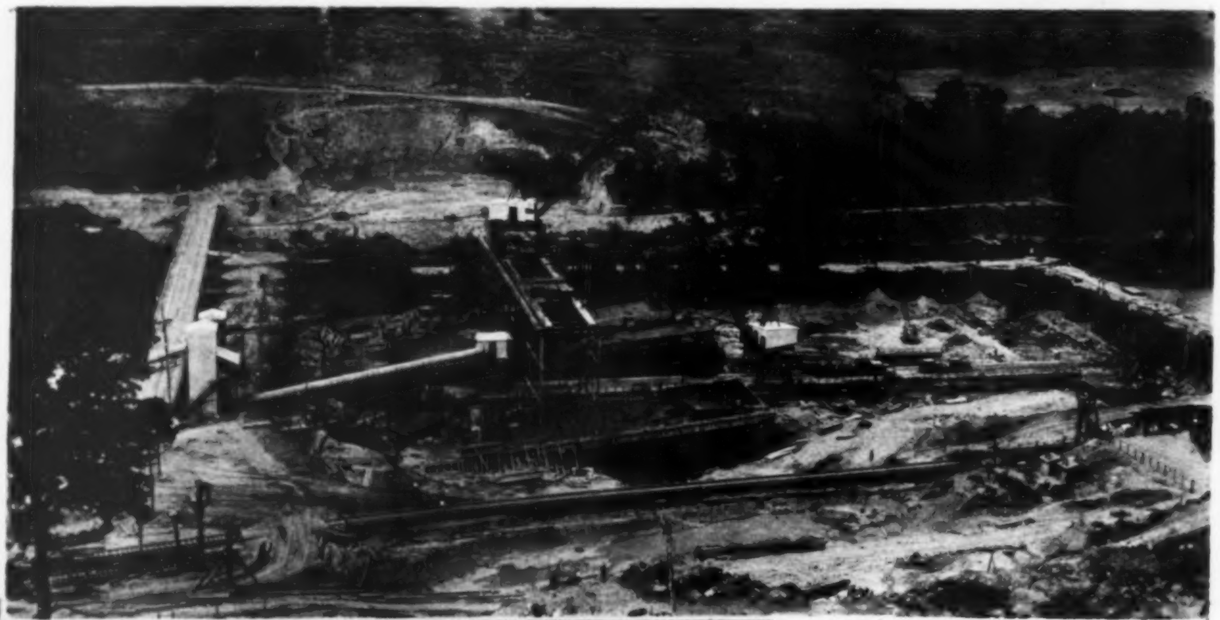
REVOLVING CRANES *on Steel Trestle* *Place Concrete in* TYGART DAM

REVOLVING CRANES, operating on a steel construction trestle built in three successive lifts to a height of 174.5 ft. and handling buckets fed with mixed concrete by a belt conveyor, are the means adopted by the Frederick Snare Corp., contractor, of New York City, for building across the Tygart River near Grafton W. Va., a straight, concrete, gravity-type dam 232 ft. in maximum height above foundations and 1,850 ft. long, with a spillway 490 ft. long and 23 ft. deep occupying its mid-section. The structure, undertaken with funds from a $10,000,000 PWA allotment to the Corps of Engineers, U. S. Army, is designed as part of a comprehensive project to prevent floods in the Pittsburgh area and also to supply water for river navigation by controlling the flow from the upper Ohio River basin. The Tygart River is tributary to the Monongahela.

Amounting to $6,305, 773 the contract for the dam and appurtenant works, awarded to the Snare organization, involves the following principal estimated quantities (the Federal government supplying all cement, piping, gates, valves and fittings): Earth excavation, 290,500 yd.; rock excavation, 68,000 yd.; concrete in dam and appurtenant works, 1,113,735 yd.; grout hole and core drilling, 237,700 lin. ft.; fill and backfill, 136,930 yd.; steel sheet piling, 8,000 sq. ft.; steel reinforcement, 1,890,000 lb.; gates, valves, pipe and fittings, 4,000,000 lb. The time allowed for the completion of the work is 1080 calendar days.

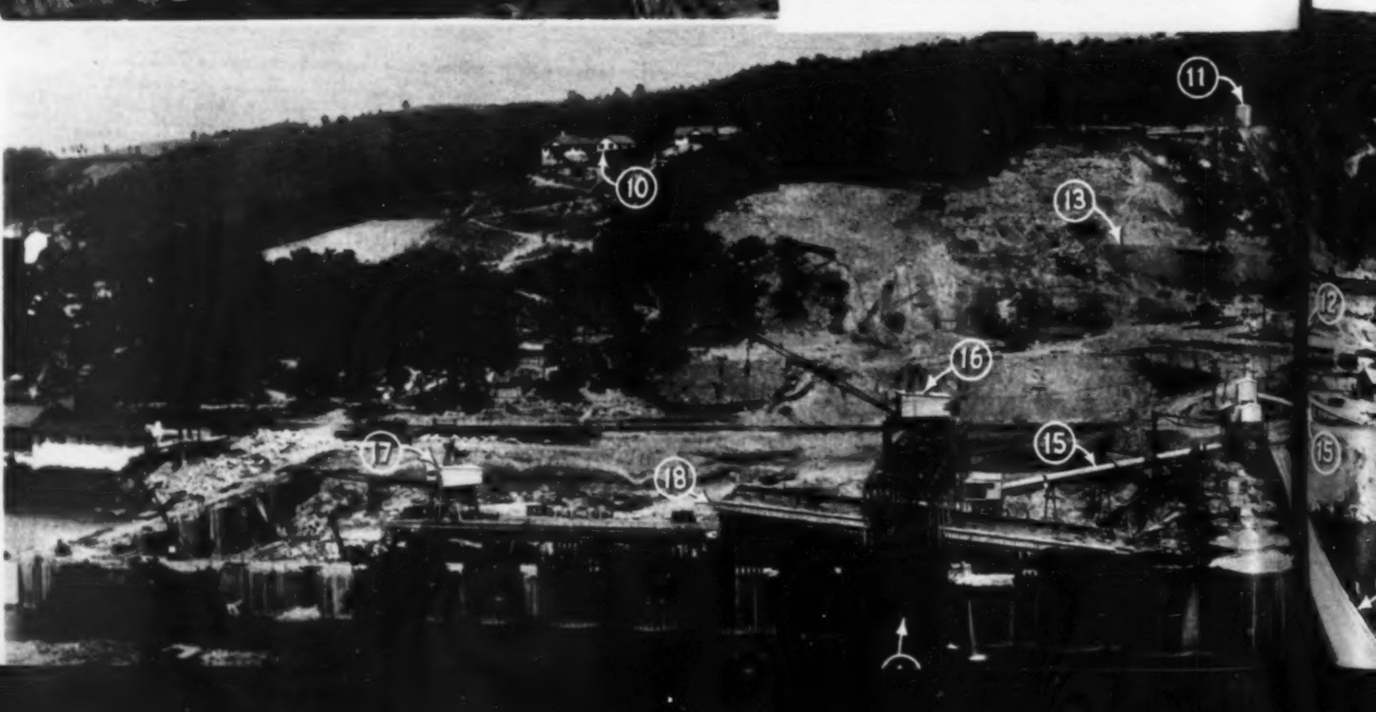
Strata of sandstone and shale constitute the foundation material at the dam site. High pressure grouting is called for in the specifications to insure the impermeability of the bedrock.

Construction Plan—The contractor's plan for building the dam at a point where the Tygart River is approximately 400 ft. wide provides for closing off the channel, successively, by two cofferdams and placing concrete by long-boom, traveling revolving cranes operating on a steel trestle, raised in three successive lifts as work progresses. Behind the first, or east, cofferdam, approximately one-half of the dam is now being concreted. When this portion of the structure is finished the second or closure cofferdam, utilizing a portion of the river wall of the first coffer, will be extended out from the west bank of the stream while the flow of the river passes through permanent outlet works openings in the completed half of the dam. Each of the two coffers is 575 ft. long and extends approximately from



STEEL CONSTRUCTION TRESTLE supporting crane carries hopper which is fed with mixed concrete by inclined belt conveyor extending upward, from left, from mixing plant.

COFFERDAM of earth-filled cellular steel sheet-pile units 575 ft. long incloses half of dam site along east bank of river. Steel trestle carries revolving crane for placing concrete in blocks with surface slopes of 10 per cent.



PLANT LAYOUT ***(below and on facing page)*** **is based on construction scheme of placing concrete within cofferdam area by revolving cranes operating on steel trestle raised in three lifts to ultimate height of 174.5 ft. Features identified by following numbers are: (1) Cofferdam 575 ft. long. (2) Construction service bridge. (3) Mixing plant, octagonal in shape, housing four 3-yd. tilting mixers. (4) Bulk cement silos. (5) Movable pump house. (6) Aggregate bin, 260 ft. long (7) Compressor building. (8) Railroad yard**

shore line to midstream. The cofferdam units are earth-filled circular cells of interlocking steel sheet piling, for the most part about 34 ft. in diameter.

Mixing Plant and Conveyors—Aggregates for concrete are received in bottom-dump railroad cars discharging into a series of covered, reinforced concrete bins 260 ft. long equipped with gates which feed a 36-in.-wide belt conveyor. This conveyor, with a maximum capacity of 550 tons per hour, carries the sand and gravel to the top of the mixing plant, equipped with Johnson batchers and four 3-yd. Smith tilting mixers grouped so that their discharge ends converge upon a central point above a 14-cu.yd. hopper. Through a power-control gate this hopper feeds the mixed concrete on to a second 36-in. belt conveyor leading to the dam. By feeding the aggregates from a central distributor head into the front or discharge ends, instead of the rear ends, of the four converging mixers, considerable height is saved in the plant design and a corresponding reduction made in the elevation to which it is necessary to carry the inclined belt conveyor delivering sand and gravel.

From the mixing plant a 36-in. inclined belt conveyor with a maximum capacity of 600 tons per hour delivers wet concrete into another 14-cu.yd. hopper mounted upon a long, fabricated steel construction trestle erected within the limits of the dam. This trestle, 64.5 ft. high for its first lift, carries three narrow-gage tracks on which operate two Lambert revolving cranes with 95-ft. booms and capacities of 8 tons at that radius. Narrow-gage cars carrying 3-cu.yd. Blaw-Knox bottom-dump buckets pass underneath the concrete supply hopper on the bridge, receive their loads of mixed concrete and are run out to points where the revolving cranes handle the buckets to the forms.

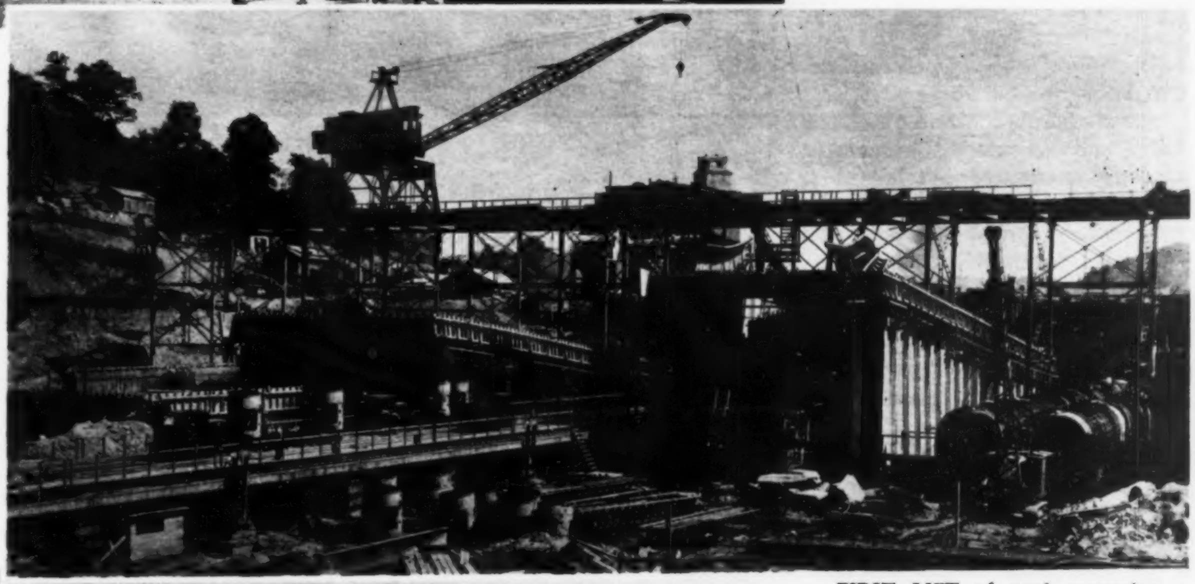
Concreting Trestle—The concreting trestle, which extends entirely across the dam site within the cofferdam areas, is of structural steel, with bolted field connections, designed for erection in three lifts as the concrete rises to its ultimate height of 232 ft. above the low point of the foundations. With its footings at El. 961 near the center of the dam the trestle is first carried up to El. 1025.5, a height of 64.5 ft. When concrete placement in the dam nears this level the second lift of the trestle is extended 65.5 ft. to El. 1080.5 and the third, and final, lift of 65.5 ft. to El. 1135.5. The total height of the steel structure thus erected in three stages for the placement of concrete and allowed to remain embedded permanently in the main body of the dam, is therefore, 174.5 ft.; its length across the dam site is 1,556 ft.

At right angles to the main high trestle there is an auxiliary low trestle for concreting the downstream apron and stilling pool section below the spillway of the dam.

The specifications require the concrete for the main dam to be placed in parallel layers not exceeding 18 in. thick on a slope of 10 per cent extending upward from the upstream to the downstream toes of the structure. The courses of concrete thus placed in 18-in. layers may be not less than 5 ft. nor more than 18 ft. thick. For consolidating the concrete both internal and surface vibration are required.

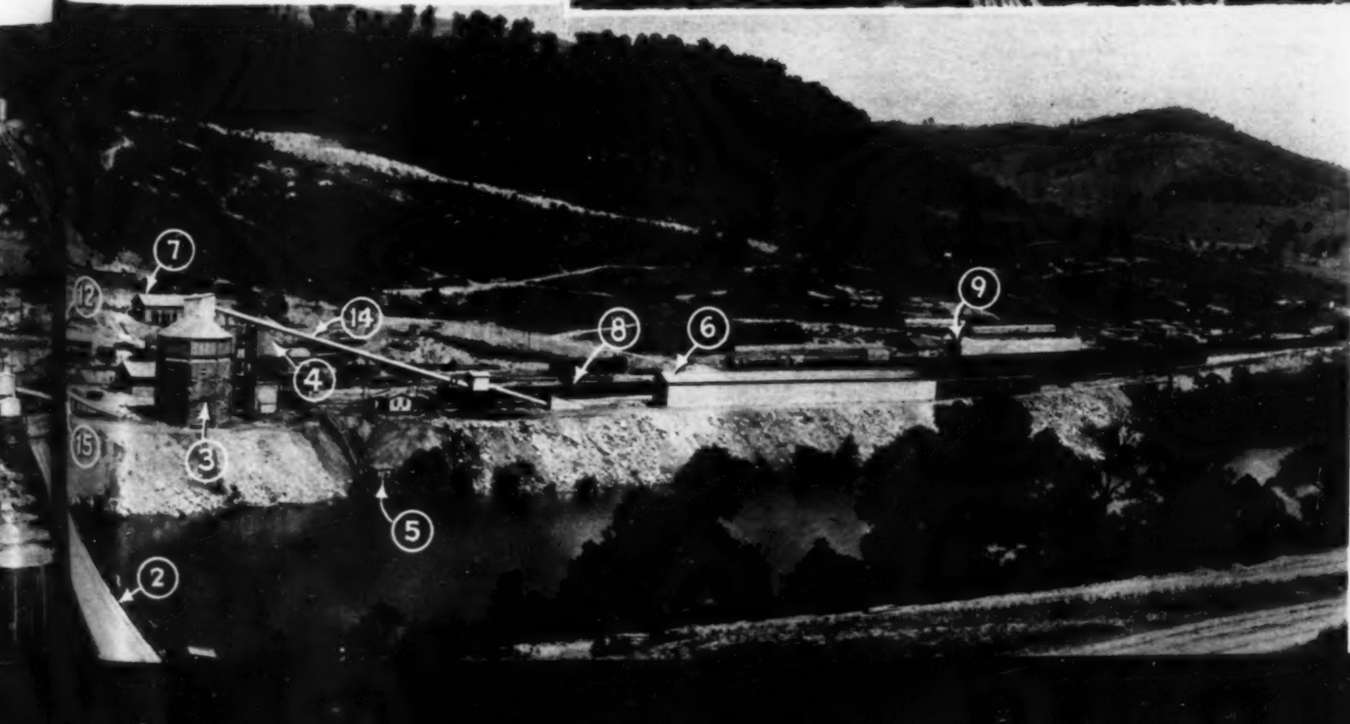
Personnel—For the construction of the Tygart River dam Major W. D. Styer, district engineer at Pittsburgh, Pa., is in charge for the Corps of Engineers. Lee G. Warren and Randall M. Cremer have acted as resident construction managers for the Frederick Snare Corp., contractor, of New York.

CONCRETING IN FULL SWING, showing two cranes on main steel trestle, with conveyor-fed hopper for mixed concrete midway between them, and third crane operating on auxiliary low trestle for concreting downstream apron section and stilling pool below spillway.



FIRST LIFT of steel concreting trestle, carrying revolving crane, is 64.5 ft. high. Two additional lifts, as concrete rises, will extend height to 174.5 ft. Trestle remains embedded in completed body of dam.

tracks. (9) Carpenter shop. (10) Cottages for construction executives. (11) 40,000-gal. steel tank for plant water storage. (12) Shop buildings. (13) Excavation for east abutment of dam. (14) Belt conveyors for sand and gravel aggregates. (15) Belt conveyors for mixed concrete. (16) Revolving crane on steel trestle for placing concrete in main body of dam. (17) Crane for placing concrete in downstream apron of dam. (18) Forms in place for concreting block of dam.



Bulldozers and Scrapers

FOUR 70-HP. TRACTORS *(left)* bulldoze loose dry soil down steep grade from highway cut to fill.

A Report by

ANDREW P. ANDERSON

Highway Engineer, Division of Management, U. S. Bureau of Public Roads

UTILIZATION of large tractor-powered bulldozers as actual excavating units and use of large capacity scrapers are comparatively recent innovations in highway grading. From time to time, these types of equipment have been observed on jobs on which production studies were being conducted by the Bureau of Public Roads, and the data thus accumulated are here summarized and briefly reviewed.

Bulldozer Operations — Bulldozers have long been standard equipment on the dump or fill, but their use in the cut as combined excavating and hauling units has, until recently, been limited. All available data, however, indicate that the bulldozer and the modified type frequently known as the "trail builder" are well adapted to moving common excavation where hauls are comparatively short and down rather steep grades and the materials are, or can be made, loose enough to permit the rapid accumulation of a load. If the material is at all hard or solid, it should be loosened with a rooter or a scarifier, or by blasting. The bulldozer is entirely satisfactory only where the ground is loose enough to permit a load to be picked up within a length of 25 to 40 ft. with the tractor moving at a speed of 2 to 2½ ft. per second. If the material is too hard or tight to permit a full load to be picked up in from 10 to 20 sec., it should be loosened with a rooter or by scarifying or blasting.

Tractor-powered bulldozers have thus far found their widest use as excavating units in conjunction with power shovels when operating in rather rough, broken country with a deep mantle of soil or deeply weathered and decomposed rocks and shales. The bulldozer has certain characteristics which appear to limit its profitable operation as an excavating implement to jobs having these general features. It is most effective in moving material down steep slopes. As the grade decreases the efficiency decreases very rapidly, and on an ascending grade the efficiency of transportation is very low.

Proper material is essential. The material must be naturally loose or at least sufficiently pliable to permit rapid and direct accumulation after loosening. Hard rocks and very hard shales can rarely be shattered sufficiently for movement with a bulldozer.

A relatively short haul is the third requirement. The tendency of the materials to spill around the ends of the bulldozer blade usually makes long movements unprofitable. Unless the grade is very steep a large load at the start will soon dwindle to a small one. Where a large yardage is moved along one path a trough or trench is formed by spillage around the ends of the blade and soon becomes sufficient to reduce further spillage. This advantage of path movement on long hauls should be utilized as soon as possible. Sometimes the spillage around the ends of the bulldozer blade can be reduced by working two bulldozers abreast with their blades only a few inches apart. Observations on a job where this was tried indicated that the yardage moved per trip by the two tractors was increased nearly 20 per cent over that moved when working independently.

HIGHWAY CUT made entirely by bulldozers. Loose material and steep grades contribute to success of bulldozer operation.

TRAIN OF MEDIUM - CAPACITY SCRAPERS is loaded by rope control from platform behind tractor. First scraper is filled, second bowl is being loaded, and third is empty.

BROKEN ROCK *(below)* must be reduced to small sizes to be handled profitably by bulldozer.

TABLE 1.—Operation Characteristics of Tractor Powered Bulldozers

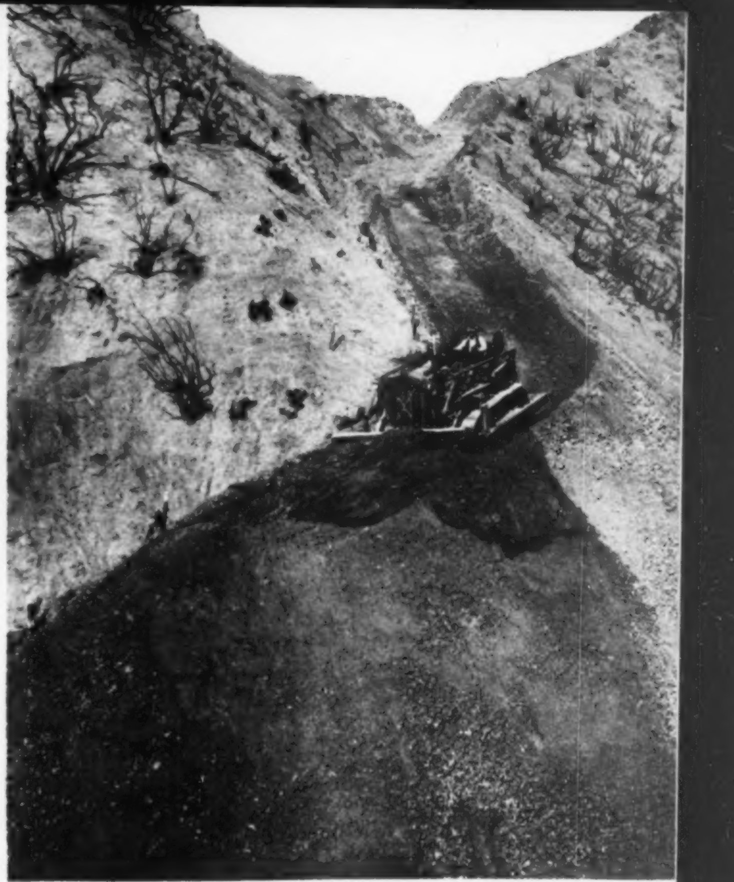
	Bulldozer No.			
	1	2	3	4
Number of trips timed	3,731	511	800	560
Cubic yards placed in fill	11,741	1,655	1,822	1,352
Production rate . . . cubic yards per hour	68.4	57.0	35.2	44.1
Pay yardage per load . . . cubic yards	3.15	3.24	2.28	2.41
Loading distance . . . feet	30.0	40.0	28.0	39.0
Loading speed . . . feet per second	2.4	2.4	1.4	2.7
Haul distance . . . feet	168	216	309	232
Hauling speed . . . feet per second	3.7	3.2	3.2	3.1
Return distance . . . feet	200	260	340	275
Return speed . . . feet per second	2.3	2.5	4.7	2.5
Average grade . . . percent	—26	—17	—11	—20
Operating cycle:				
Load . . . seconds	12.6	16.6	20.6	14.3
Reverse or turn at dump . . . do	1.9	2.0	2.6	2.5
Turn or shift at cut . . . do	2.0	2.4	2.8	2.4
Minor time losses, percentage of working time	12.6	14.5	18.0	16.2
Size of blade . . . feet	4 by 10	3 by 11.5	4 by 10	4 by 10
Rated horsepower of tractor	65	65	60	60

Function as Excavators

A bulldozer is particularly useful in conjunction with a power shovel. On steep ground the pioneer road work necessary for the shovel to reach the first lift of a deep cut can frequently be greatly reduced and sometimes entirely eliminated by having the bulldozer build up both an approach for the shovel and a hauling road for the trucks or wagons. Often a cut which would normally be made in two or three lifts may be reduced in this way by one lift and better hauling roads provided because of the adaptability of the bulldozer to the conditions. With the bulldozer this work generally can be done with the movement of only pay materials, whereas the older method frequently requires the movement of considerable quantities of non-pay materials in the construction of approach roads in zigzags up steep hillside slopes.

The best operating speed at which to haul the loads is still largely a matter of opinion. The general practice is to work at about the maximum speed possible without obviously straining the power unit. This practice may be entirely correct for many or possibly most cases. It was noted during recent job studies that in moving loose, noncohesive materials down steep grades the amount of material which would push or flow in front of the blade was much larger at a speed of 2 ft. or less per second than for a speed of 3½ ft. per second. There appears to be some optimum speed which will yield the greatest production, at least when moving loose, noncohesive materials down steep grades. However no definite data are available as to what this most productive speed is or how it may vary with different materials and slopes.

DRY, GRANULAR MATERIALS *(right)* move readily in large volume with apparent flowing motion at slow to moderate bulldozer speeds on steep grades.



PROFITS in scraper operation depend largely on carrying full load to dump.

Sidehill Grading—Bulldozers have been found effective in sidehill work. Work usually is begun along the upper line of slope stakes and the material moved ahead and to the side as the conditions may require. So long as the material is loose or can be loosened and the haul distance is short enough to maintain a rather steep grade along which to move the material, good production rates can be maintained.

HARD MATERIALS must be scarified or otherwise loosened to enable bulldozers to pick up load in 25 sec.

Opening a cut with the bulldozer in ground as described above is comparatively simple, although on very steep ground considerable skill and ingenuity are required in maneuvering the bulldozer in its climb to the very top of the cut. Once this point has been reached the bulldozer begins to dig along the highest point of the upper slope line. The excavated material is pushed ahead toward the fill. If the ground slope is steeper than the tractor can readily climb in reverse, the material is simply pushed clear of the immediate excavation and allowed to accumulate along the line of the hauling road until a runway is provided with flat enough grade to permit the bulldozer to return readily in reverse after delivery of its loads to the fill. If the ground slope is already flat enough for the tractor to return fairly easily, every load is carried to the fill. In both cases the slope of the hauling road for the bulldozer is kept as steep as possible because, within limits, the steeper the grade the larger the load which can be carried to the fill.

As the work progresses the runway finally is widened to include the full width of the cut. In a wide cut three or four bulldozers sometimes can be operated without interference, and an even greater number if the haul is in both directions. If the material becomes too hard for easy loading, a heavy scarifier or rooter drawn by a powerful tractor may be used to loosen it. If the

PNEUMATIC-TIRED 12-YD. SCRAPER *(below)* drawn by 75-hp. tractor unloads material by pushing it out of bowl with cable-operated rear plate.

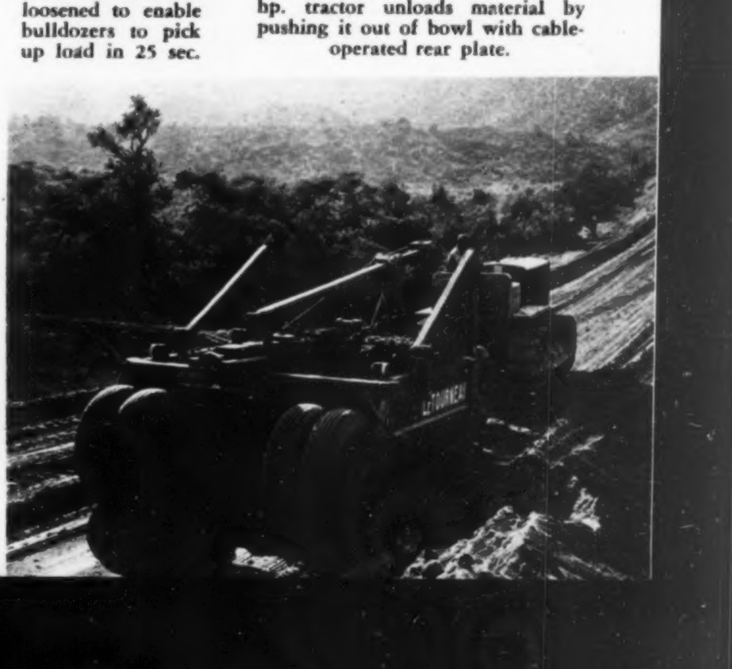


TABLE 2.—Operating Characteristics of Large Scrapers

	Scraper No. 1	2	3	4	5	6	7	8
Rated capacity ....cubic yards..	3	6	8	4	5	4	4	5
Condition of equipment	Good	Very good	Very good	Very good	Very good	Fair	Good	Fair
Number of round trips timed........	212	269	132	145	54	56	3,200	963
Loading distance........feet..	75	116	144	80	86	92	100	38
Loading speed........feet per second.	2.3	1.8	2.0	2.1	2.0	1.8	2.0	2.3
Hauling distance........feet..	180	327	290	210	372	1,400	300	237
Hauling speed........feet per second..	2.9	3.5	2.8	3.0	3.2	3.0	2.5	3.3
Return distance........feet..	254	405	449	280	450	1,450	400	275
Return speed........feet per second..	3.2	3.8	3.8	3.7	3.8	4.7	5.5	2.7
Dumping time........seconds..	10.4	....	....	....	46.0	34.0	11.0	10.4
Turning time........do....	18.0	22.0	20.0	24.0	27.0	22.0	20.0	....
Size of load carried to dump, percentage of apparent full load	95.0	75.0	50.0	90.0	61.0	75.0	90.0	....
Average pay yardage in percentage of rated load capacity	57.0	45.0	35.0	54.0	37.0	45.0	53.0	44.0

END-GATE TYPE OF SCRAPER travels to dump with gate closed and body raised clear of ground.

ground becomes still harder, blasting should be utilized. The harder rocks and shale seldom can be reduced sufficiently to make the use of the bulldozer profitable. When rock or ground of this nature is reached further work is left to the power shovel.

The steeper the grade the larger the load which can be carried to the fill and the longer the haul on which the bulldozer can be used profitably. The only limit to the grade is the ability of the tractor to climb on the return. A large crawler tractor in good condition and equipped with a 10-ft. standard bulldozer has been observed to climb a grade as steep as 50 per cent.

Production Studies—Field observations indicate that the average load which can be carried from cut to fill under ordinary field conditions varies with the length and shape of the blade, the grade along which the load is moved, and the character of the material. The observations are confirmed to some extent by the data of table 1. During recent studies of the use of four bulldozers in moving considerable yardages it was found that loads frequently fluctuated as much as 100 per cent. For a certain bulldozer the smallest loads would be about 2 cu. yd., and the largest loads would be about 4 cu. yd.

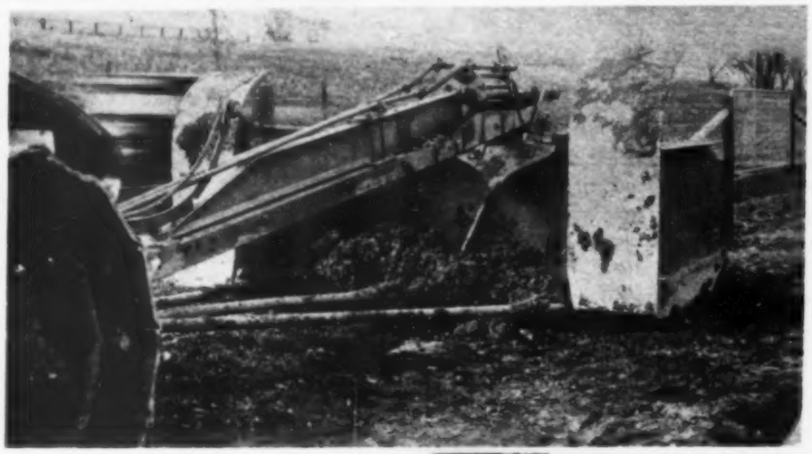
Recent improvements in control which permit independent vertical movement of either end of the bulldozer and also lateral movement have considerably improved the utility. It is easier to keep the entire cut in proper condition for easy operation, and to shape the slopes at the proper angle. These features are particularly valuable in sidehill work.

Tractor-Drawn Scrapers—Large tractor-drawn scrapers have been studied on a few grading jobs having large quantities of short-haul common excavation. These scrapers ranged in rated capacity from 3 to 8 cu. yd. of loose material and were six different makes. The number of different makes indicates that this type of equipment is far from standardized. However, the scrapers observed may be divided into two distinct classes: Those which carry the load pan or scoop clear of the road, and those which drag the load pan or cutting blade so as to transport a part or all of the load by pushing it ahead of the pan or cutting blade.

Some of those which lift the pan have definite provisions for preventing or reducing spillage while the load is being hauled to the dump. These provisions vary from substantial self-closing gates to simply tilting the load pan to such an angle that the tendency for the material to spill out is greatly reduced. In the other class, the pan is raised very little for the haul and spillage is prevented or at least neutralized by accumulating and dragging material in front of the pan.

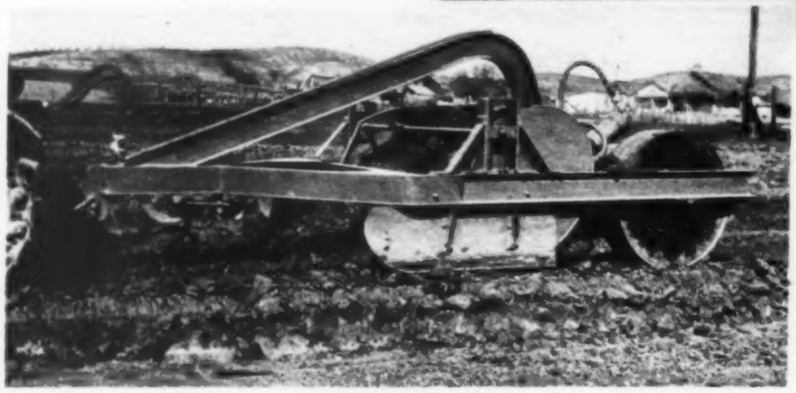
Adjusting the pan so as to drag material produced a considerable effect on the hauling speed. When the scraper was hauled with the load pan clear of the ground the hauling speed was generally 30 to 50 per cent higher than when the pan dragged sufficiently to retain a full load. The effect of reduced speed, however, seemed fully compensated by the increased load. With the pan hoisted entirely clear of the roadway, the loss from spillage on steep or rough down grades was as much as one half of the original load when the soil was dry and noncohesive. Considerable difficulty sometimes was experienced in dumping the gate type scraper when working in sticky or plastic materials.

Results of observations on four jobs using six different types of scrapers are shown in table 2. Scrapers 1, 2, 3, 4 and 5 were all on one job and operated under fairly similar conditions. Job 7 was observed only in the winter when the materials were wet, sticky, and difficult to handle. Scrapers 1 and 7 and 5 and 6 were of the same makes and types but were observed on different jobs and under different conditions.

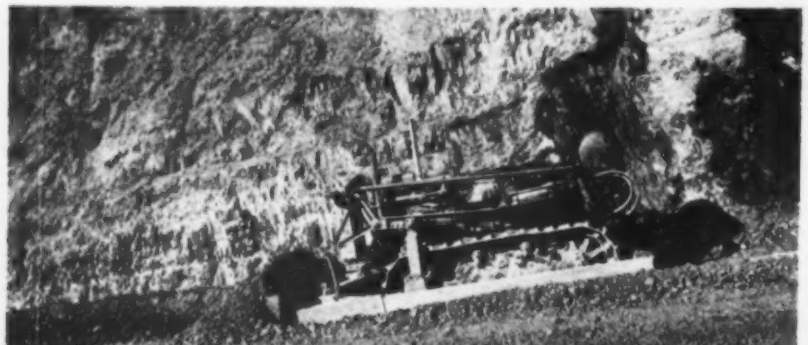


DRAG-TYPE SCRAPER dumps by overturning bowl on to front shoes.

OPEN-FRONT SCRAPER ***(right)*** in loading position. This scraper is dumped by drawing back plate forward with cables attached to winch on tractor.

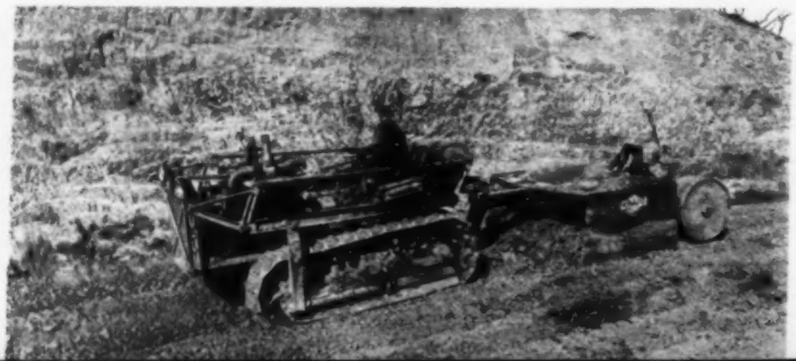


SCRAPER LEAVES CUT with full load, pushing much material ahead of bowl. On long, rough haul or steep down grade, loss by spillage may be large.



MATERIAL OF THIS TYPE can be loosened by scarifier and moved by bulldozer.

NONCOHESIVE, GRANULAR MATERIALS ***(below)*** have tendency to spill from open-front scrapers on haul to dump.



Present and Accounted For—

A Page of Personalities

LIEUT.-COL. FRANCIS C. HARRINGTON, Corps of Engineers, U. S. Army has been named chief engineer of the Works Progress Administration, with headquarters at Washington, D. C. He served as Military Attache to the American Embassy in Paris, France, prior to receiving orders to report as engineer in charge of the Second New Orleans District of the Engineer Department.

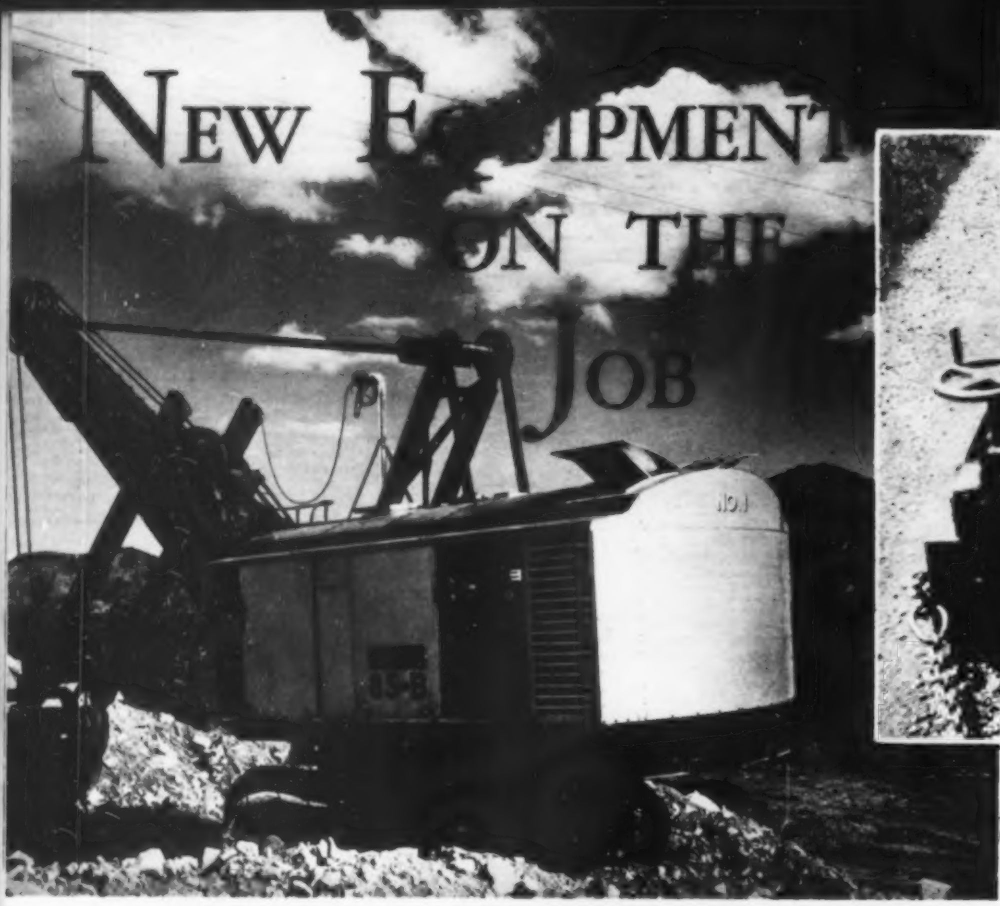
COVERED WAGON DAYS were recalled in the elaborate "Pageant of Transportation" staged during recent dedication of new $200,000 state highway bridge near Cadillac, Mich., named in honor of Dean Mortimer E. Cooley *(Second from right)* of the University of Michigan. In group are*(left to right):* Murray D. Van Wagoner, Michigan Highway Commissioner; Mayor H. H. Hill, of Manistee; Miss Genevieve Pepera. National Cherry Festival Queen; Dean Cooley and W. E. Curry, of Cadillac.

JOHN C. PAGE, formerly office engineer for the U. S. Bureau of Reclamation and second in command at Boulder dam, has been appointed chief of the Bureau's Engineering Division in Washington, D. C. Mr. Page has served with the Reclamation Bureau since 1909 and for years was superintendent of the Grand Valley project in Colorado.

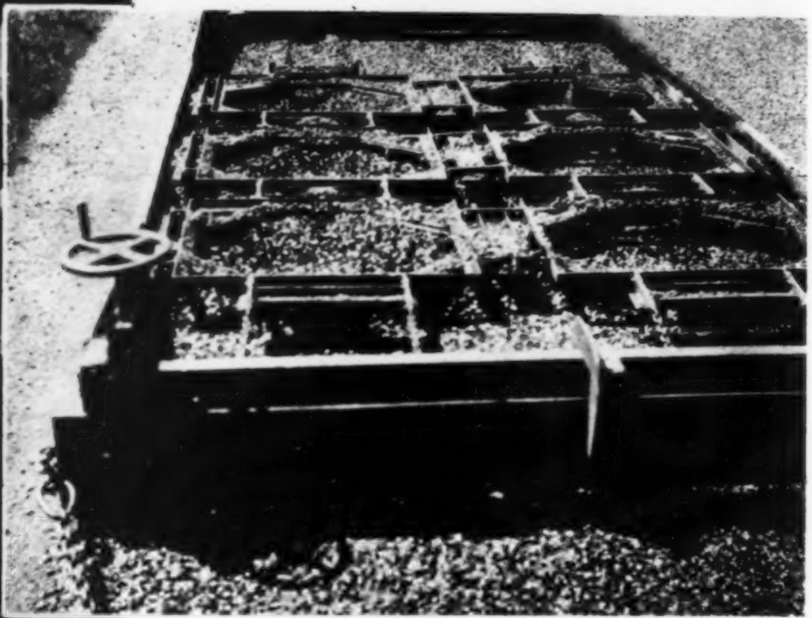
J. S. WILLIAMSON, formerly assistant state highway engineer, has been promoted to state highway engineer of South Carolina. After graduation from Clemson College and three years of service with the Southern Power Co., he entered the South Carolina Highway Department in 1922 and remained with the organization in various positions, including that of resident engineer and division engineer.

MEMBERS OF ALL- AMERICAN CANAL AND GRAND COULEE DAM BOARDS *(below)* meet in Washington headquarters of U. S. Bureau of Reclamation. *(left to right)* Dr. Elwood Mead, Commissioner of Reclamation; C. H. Paul, Joseph Jacobs, W. F. Durand, consulting engineers; Dr. C. P. Berkey, consulting geologist; R. F. Walter chief engineer; J.L. Savage, chief designing engineer; L. N. McClellan, chief electrical engineer; John C. Page, senior engineer, (recently promoted to chief of Engineering Division.)

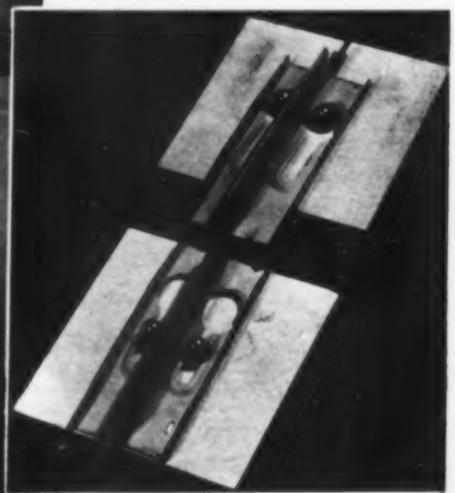
New Equipment on the Job



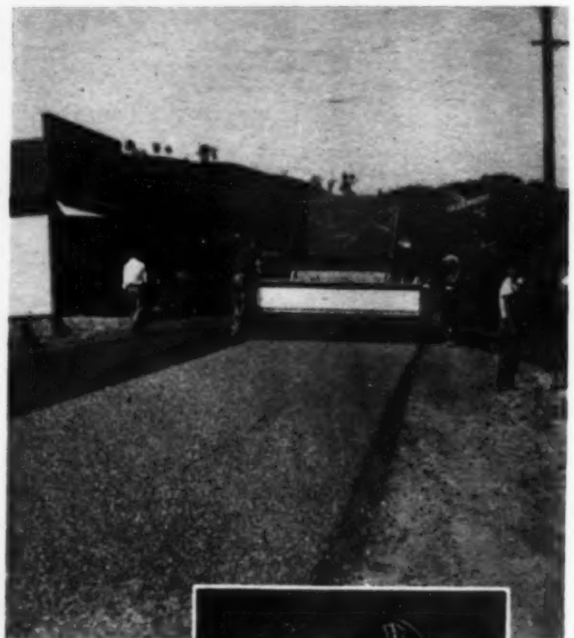
HEAVY-DUTY CONVERTIBLE Shovel-Dragline for quarry, mine and construction operations has unusual speed, power and strength gained through use of special heat-treated alloy steels, electric-welded construction and Ward-Leonard control. All-welded base is supported on two heavy cast side girders which form frame for crawler rollers and tumblers. Welded box-girder boom with outside dipper handles. Special rock dipper made of two strong steel castings riveted and keyed together. Variable-voltage direct-current field control with separately excited shunt-wound motors permits operator to complete entire digging cycle without use of brakes or clutches, thus eliminating adjustment and maintenance of these parts and giving operator control over dipper at all times. As dragline, machine will handle 3-yd. heavy-duty bucket on 65-ft. boom. Weight, as shovel, 224,000 lb.—Bucyrus-Erie Co., South Milwaukee, Wis.



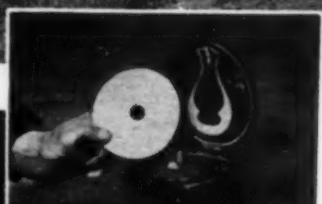
LEVELER GRADER, for cutting down high spots and filling ruts on black top, macadam and gravel roads, consists of two 20-ft. steel runners on which are mounted front strikeoff plate adjustable by hand wheels to permit desired amount of material to flow through drag; six floating blades equipped with hinged gates to regulate movement and to assure thorough mixing action of materials, and rear strikeoff plate to gage amount of material spread. Made in two 10-ft. sections for shipping and handling and in 8-, 9- and 10-ft. widths. Works automatically in either direction.—Heltzel Steel Form & Iron Co., Warren, Ohio.

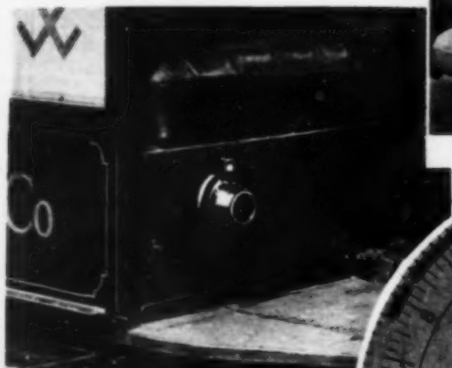


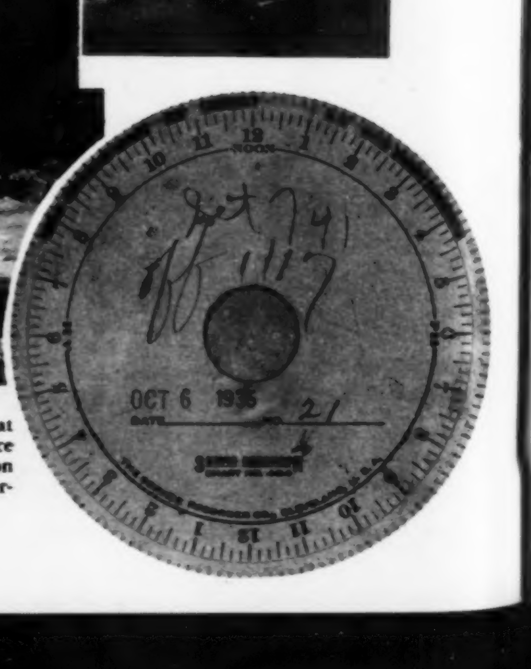
WALLS AND PARTITIONS *(above)* designed to meet constantly changing demands of floor space are rapidly erected, readily removed and completely salvaged. Made of asbestos fibre and portland cement compressed under high pressure into 7/16-in.-thick dense, rigid, homogeneous sheets, called Transite, which are fireproof and possess great structural strength and durability. Floor and ceiling channels of 20-gage steel carry steel studs and hold them in transverse alignment. In flanges of studs are double row of embossed keyhole slots. Wall sheets are equipped with blind holding devices which are inserted into slots of studs and hold sheets in proper position withstanding 800-lb. pull. Weight of partition is 12½ lb. per square foot. Walls may be decorated as desired.—Johns-Manville Co., 220 East 40th St., New York City.



SURFACE MATERIAL SPREADER *(right)* for distributing all types of material from sand to 1-in. stone consists of 1-yd.-capacity spreader box 9 ft. long by 44 in. wide equipped with 5⅝- in. feed roll and mounted on wide wheels spaced 50 in. apart. Attached to truck by rugged coupling. Material is deposited in hopper of spreader box from dump body of truck and spread by feed roll in accurately controlled volume on road. Width of spread is uniform for any width desired up to full width of spreader. Works equally well, forward or in reverse. Can be lifted by attaching with chains and hauled from one job to another at truck speed. Buckeye Traction Ditcher Co., Findlay, Ohio.







PERFORMANCE RECORDING DEVICE, called "Servis Recorder," increases efficiency of trucks. Consists of simple mechanism attached to dashboard of truck *(right)* into which is locked a parrafin coated disk *(small photo, right)* which revolves, by clockwork. As disk *(right)* revolves, line is drawn on it by pen. When truck is in motion, heavy line is recorded; when not in motion, thin line is recorded. Position of line indicates time of day at which lines were produced. Device facilitates control over truck operation by indicating idle time.—Service Recorder Co., Cleveland, Ohio.

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Tough loads? Of course! That's what dump trucks are built for. And so are Goodyear Dump Truck Tires. That's why you see so many dump trucks, everywhere, rolling on Goodyears.

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(THE NUMBERS CORRESPOND TO PLANT LOCATIONS SHOWN ON THE MAP)

1. **Aetna Portland Cement Co.,** Detroit, Mich.
Mills: Fenton, Mich.; Bay City, Mich.

2. **Allentown Portland Cement Co., The,** Catasauqua, Pa.
Mill: Evansville (Berks County), Pa.

3. **Alpha Portland Cement Co.,** Easton Pa.
Mills: Martins Creek, Pa.; Manheim, W. Va.; Jamesville, N. Y.; Cementon, N. Y.; Bellevue, Mich.; LaSalle, Ill.; Ironton, Ohio; St. Louis, Mo.; Phoenixville (Birmingham P. O.), Ala.

5. **Ash Grove Lime & Portland Cement Co.,** Kansas City, Mo.
Mills: Louisville, Neb.; Chanute, Kan.

8. **British Columbia Cement Co., Ltd.,** Victoria, B. C.
Mills: Tod Inlet, B. C.; Bamberton, Saanich Inlet, B. C.

9. **Calaveras Cement Co.,** San Francisco, Calif.
Mill: San Andreas, Calif.

10 ***California Portland Cement Co.,** Los Angeles, Calif.
Mill: Colton, Calif.

11. **Canada Cement Company, Ltd.,** Montreal, Que.
Mills: Belleville, Ont.; Montreal, Que.; Montreal, East, Que.; Hull, Que.; Lakefield, Ont.; Port Colborne, Ont.; Exshaw, Alta.; Winnipeg, Man.

17. **Crescent Portland Cement Co.,** Pittsburgh, Pa.
Mill: Wampum, Pa.

18. **Cumberland Portland Cement Co.,** Cowan, Tenn.
Mill: Cowan, Tenn.

19. **Dewey Portland Cement Co.,** Kansas City, Mo.
Mills: Dewey, Okla.; Davenport, Ia.

20. **Diamond Portland Cement Co.,** Middle Branch, Ohio.
Mill: Middle Branch, Ohio.

23. **Florida Portland Cement Co.,** Tampa, Fla.
Mill: Tampa, Fla.

25. **Georgia Cement & Products Co.,** Birmingham, Ala.
Mill: Portland, Ga.

26. **Giant Portland Cement Co.,** Philadelphia, Pa.
Mill: Egypt (Lehigh County), Pa.

27. **Glens Falls Portland Cement Co., The,** Glens Falls, N. Y.
Mill: Glens Falls, N. Y.

28. **Great Lakes Portland Cement Corp.,** Buffalo, N. Y.
Mill: Buffalo, N. Y.

29. **Green Bag Cement Company of Pennsylvania,** Pittsburg, Pa.
Mill: Neville Island, Pittsburgh.

31. **Hawkeye Portland Cement Co.,** Des Moines, Ia.
Mill: Des Moines, Ia.

32. **Hercules Cement Corp.,** Philadelphia, Pa.
Mill: Nazareth, Pa.

33. **Hermitage Portland Cement Co.,** Nashville, Tenn.
Mill: Nashville, Tenn.

34. **Huron Portland Cement Co.,** Detroit, Mich.
Mills: Alpena, Mich.; Wyandotte, Mich.

International Cement Corp. (See Lone Star companies).

37. **Kosmos Portland Cement Co.,** Louisville, Ky.
Mill: Kosmosdale (Jefferson County), Ky.

39. **Lehigh Portland Cement Co.,** Allentown, Pa.
Mills: Ormrod, Pa.; Newcastle, Pa.; Mitchell, Ind.; W. Coplay, Pa.; Fogelsville, Pa.; Sandts Eddy, Pa.; Bath, Pa.; Alsen, N. Y.; Mason City, Ia.; Metaline Falls, Wash.; Iola, Kan.; Oglesby, Ill.; Union Bridge, Md.; Fordwick, Va.; Birmingham, Ala.

40. **Lone Star Cement Corp.,** New York, N. Y.
Mills: Birmingham, Ala.; Spocari, Ala.; Bonner Springs, Kan.; New Orleans, La.; Nazareth, Pa.; Norfolk, Va.

41. **Lone Star Cement Co., Indiana, Inc.,** Indianapolis, Ind.
Mill: Limedale (Greencastle P. O.), Ind.

42. **Lone Star Cement Co., New York, Inc.,** Albany, N. Y.
Mill: Hudson, N. Y.

43. **Lone Star Cement Co., Texas,** Dallas, Tex.
Mills: Dallas, Tex.; Houston, Tex.

44. **Louisville Cement Co.,** Louisville, Ky.
Mill: Speed, Ind.

45. **Manitowoc Portland Cement Co.,** Manitowoc, Wis.
Mill: Manitowoc, Wis.

46. **Marquette Cement Manufacturing Co.,** Chicago, Ill.
Mills: LaSalle, Ill.; Cape Girardeau, Mo.

47. **Medusa Portland Cement Co.,** Cleveland, Ohio.
Mills: York, Pa.; Bay Bridge, Ohio; Toledo, Ohio; Dixon, Ill.

48. **Missouri Portland Cement Co., The,** St. Louis, Mo.
Mills: Kansas City, Mo.; St. Louis, Mo.

49. **Monarch Cement Co., The,** Humboldt, Kan.
Mill: Humboldt, Kan.

50. **Monolith Portland Cement Co.,** Los Angeles, Calif.
Mill: Monolith, Calif.

52. **National Cement Co.,** Birmingham, Ala.
Mill: Ragland, Ala.

53. **Nazareth Cement Co.,** Nazareth, Pa.
Mill: Nazareth, Pa.

54. **Nebraska Cement Co.,** Omaha, Neb.
Mill: Superior, Neb.

55. **Newaygo Portland Cement Co.,** Grand Rapids, Mich.
Mill: Newaygo, Mich.

56. **North American Cement Corp.,** Albany, N. Y.
Mills: Howe's Cave, N. Y.; Security, Md.; Catskill, N. Y.

57. **Northwestern Portland Cement Co.,** Seattle, Wash.
Mill: Grotto, Wash.

58. **Northwestern States Portland Cement Co.,** Mason City, Ia.
Mills: Mason City, Ia.; Gilmore City, Ia.

59. **Oklahoma Portland Cement Co.,** Oklahoma City, Okla.
Mill: Ada, Okla.

60. **Olympic Portland Cement Co., Ltd., The,** Seattle, Wash.
Mill: Bellingham, Wash.

62. **Pacific Portland Cement Co.,** San Francisco, Calif.
Mills: Redwood City, Calif.; San Juan Bautista, Calif.

63. **Peerless Cement Corp.,** Detroit, Mich.
Mills: Detroit, Mich.; Port Huron, Mich.

64. **Pennsylvania-Dixie Cement Corp.,** New York, N. Y.
Mills: Nazareth, Pa.; Kingsport, Tenn.; Clinchfield, Ga.; Portland Point, N. Y.; Richard City, Tenn.; Bath, Pa.; Des Moines, Ia.

65. **Petoskey Portland Cement Co.,** Petoskey, Mich.
Mill: Petoskey, Mich.

66. **Pittsburgh Plate Glass Co.,** Columbia Cement Division, Pittsburgh, Pa.
Mill: Fultonham (Zanesville P. O.), Ohio.

68. **Republic Portland Cement Co.,** San Antonio, Tex.
Mill: Longhorn (Wetmore P. O.), Tex.

69. **Riverside Cement Co.,** Los Angeles, Calif.
Mills: Crestmore, Calif.; Oro Grande, Calif.

70. **St. Mary's Cement Co., Ltd.,** Toronto, Ont.
Mill: St. Mary's, Ont.

71. **San Antonio Portland Cement Co.,** San Antonio, Tex.
Mill: Cementville, Tex.

73. **Signal Mountain Portland Cement Co.,** Chattanooga, Tenn.
Mill: N. Chattanooga, Tenn.

74. **Southern States Portland Cement Co.,** Rockmart, Ga.
Mill: Rockmart, Ga.

75. **Southwestern Portland Cement Co.,** Los Angeles, Calif.
Mills: El Paso, Tex.; Osborn, Ohio; Victorville, Calif.

76. **Spokane Portland Cement Co.,** Spokane, Wash.
Mill: Irvin, Wash.

77. **Standard Lime & Stone Co.,** Baltimore, Md.
Mill: Martinsburg, W. Va.

78. **Standard Portland Cement Co.,** Cleveland, Ohio
Mill: Painesville, Ohio.

79. **Superior Cement Corp.,** Portsmouth, Ohio
Mill: Superior (Lawrence County), Ohio.

80. **Superior Portland Cement, Inc.,** Seattle, Wash.
Mills: Concrete, Wash.; Seattle, Wash.

82. **Trinity Portland Cement Co.,** Dallas, Tex.
Mills: Eagle Ford (Dallas P. O.), Tex.; Fort Worth, Tex.; Houston, Tex.

85. **Universal Atlas Cement Co.,** Chicago, Ill.
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Mill: Knoxville, Tenn.

89. **Wabash Portland Cement Co.,** Detroit, Mich.
Mills: Stroh, Ind.; Osborn, Ohio.

90. **West Penn Cement Co.,** Butler, Pa.
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92. **Wolverine Portland Cement Co.,** Coldwater, Mich.
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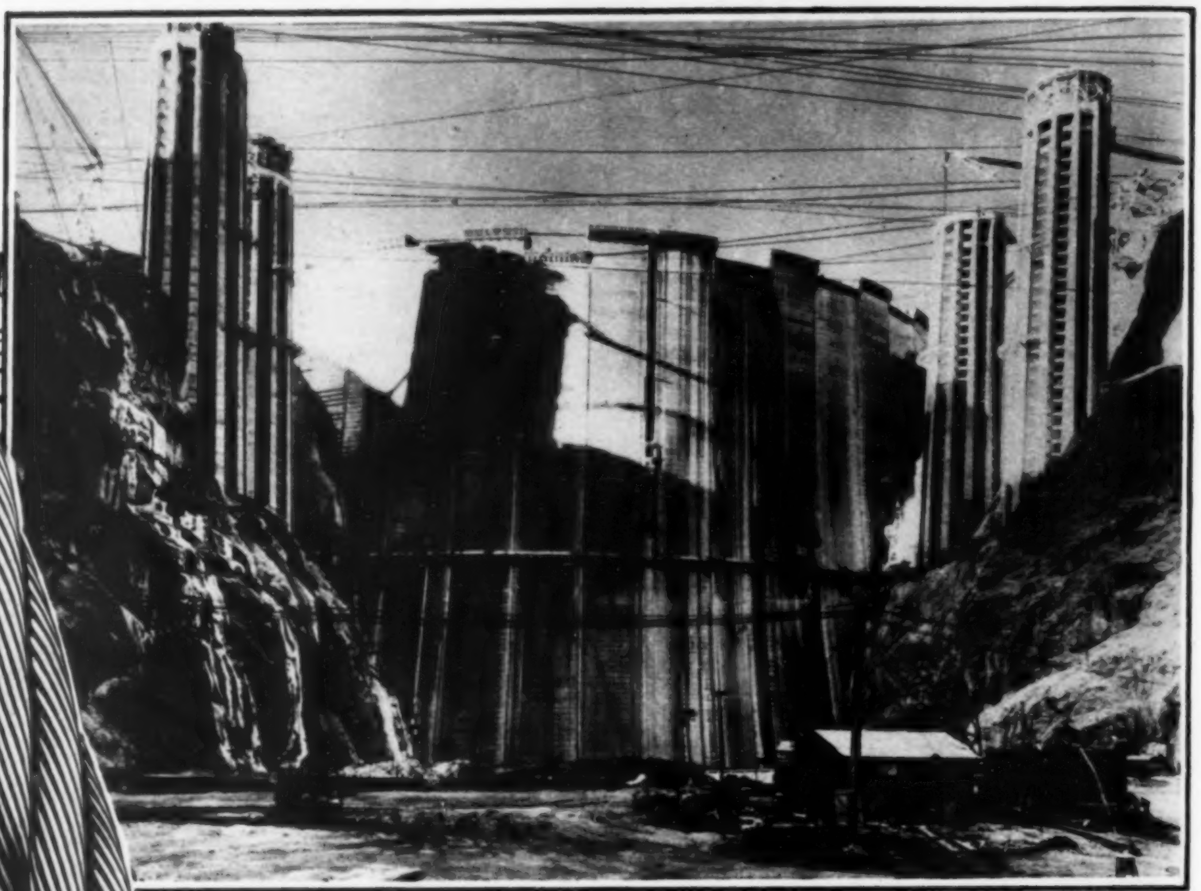

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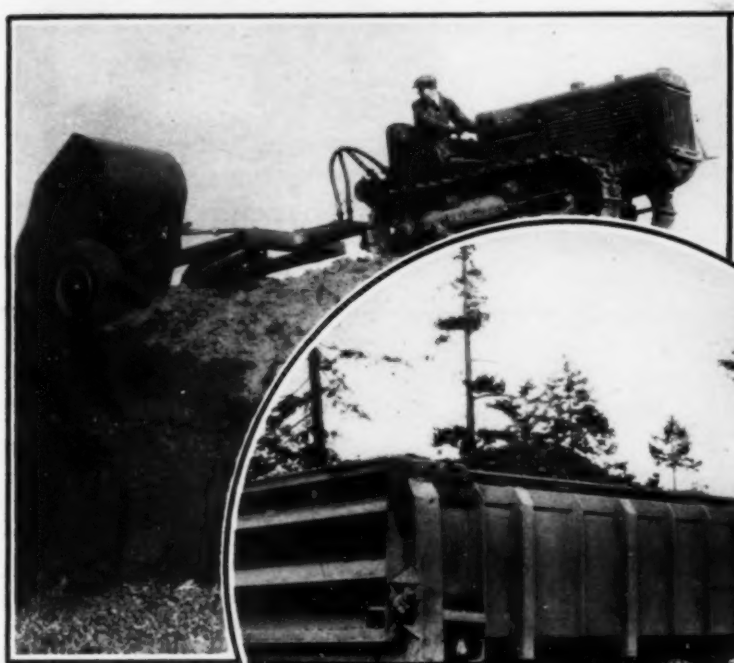

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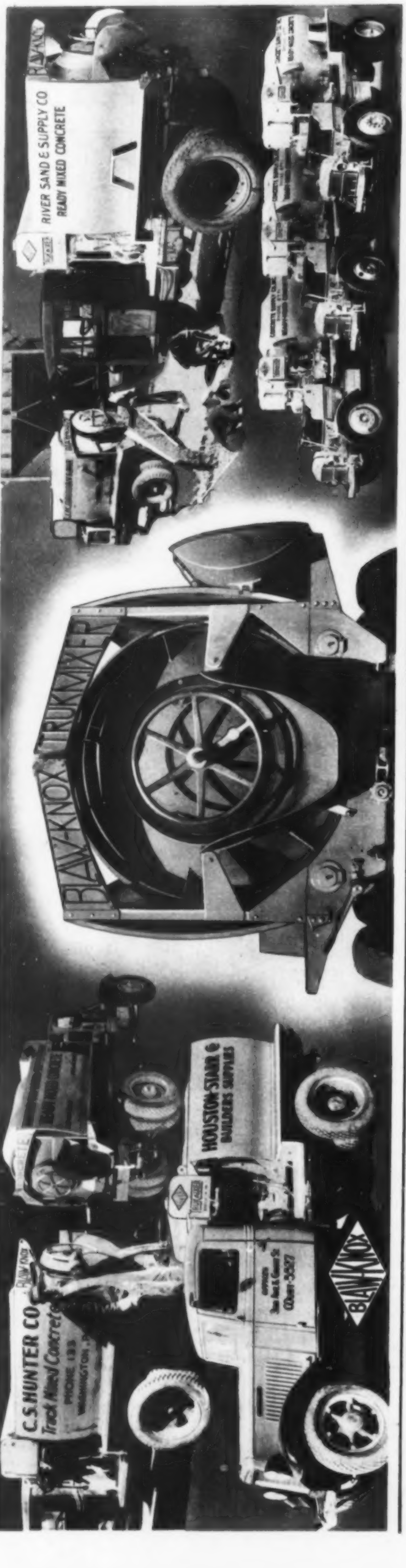

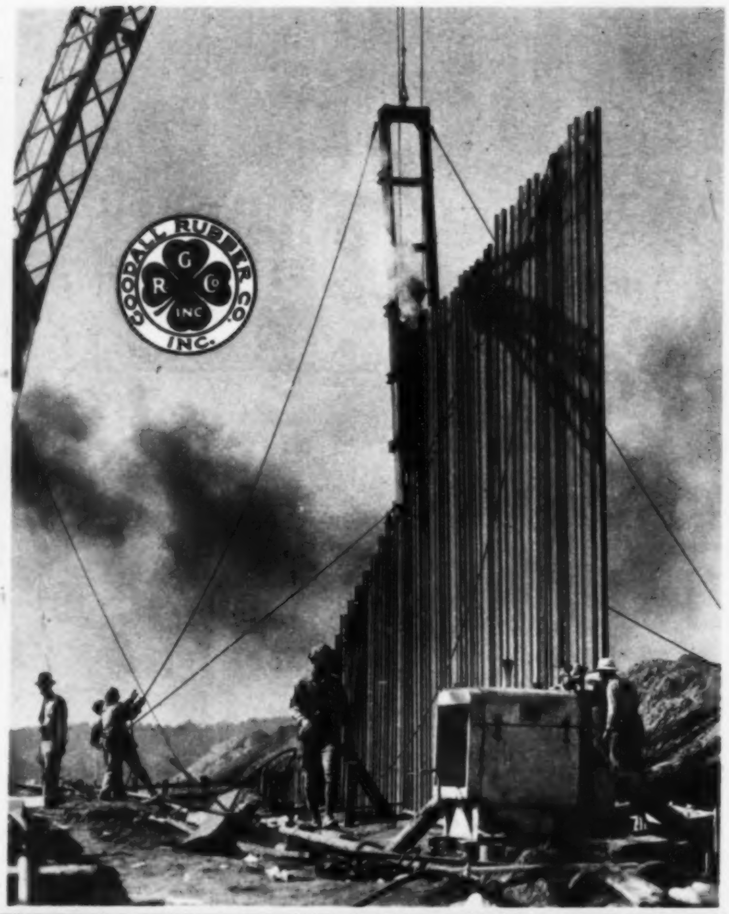

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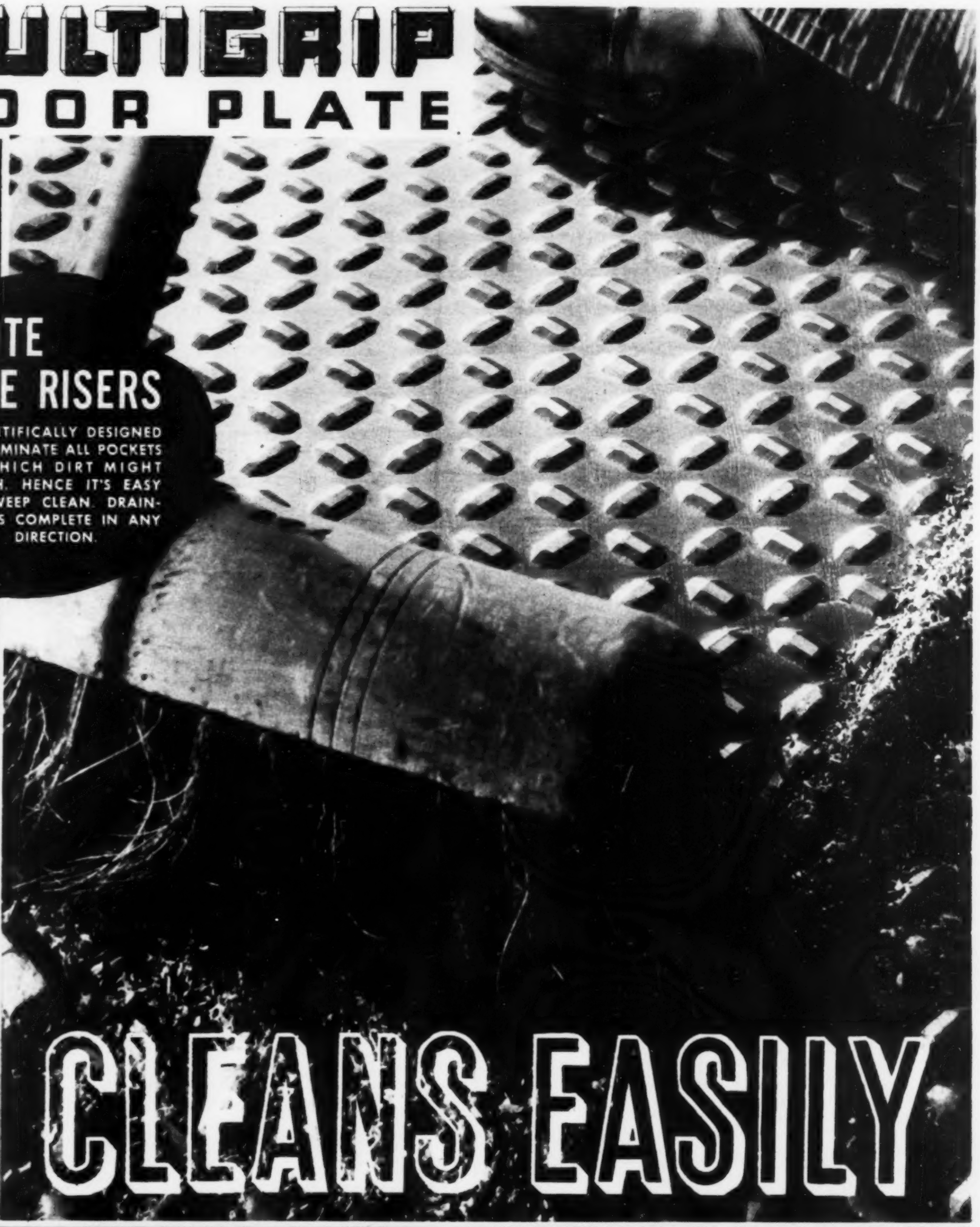

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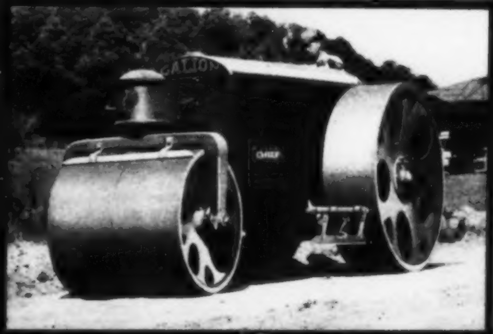

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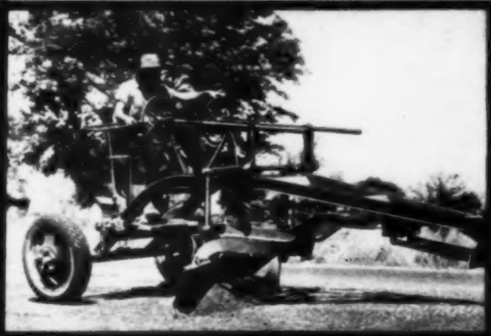

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State of New York,)
County of New York,) ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared D. C. McGraw, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Construction Methods and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933 embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, N. Y. C.; Editor, Robert K. Tomlin, 330 West 42nd Street, N. Y. C.; Managing Editor, none; Business Manager, William Buxman, 330 West 42nd Street, N. Y. C.

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is.
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D. C. McGraw, Secretary.
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Sworn to and subscribed before me this 26th day of September, 1935.
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Notary Public, Nassau County. Clerk's No. 66, N.Y. Clerk's No. 118. Reg. 6-B-73. (My commission expires March 30, 1936)

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